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Giuseppe Acerbi
[illegible]
4º 4.

ON

THE LIGNITE FORMATION

OF

BOVEY TRACEY,

DEVONSHIRE.

BIBLIOTHECA BODLEIANA

BY

WILLIAM PENGELLY, F.R.S., F.G.S., &c.,

AND

THE REV. OSWALD HEER,

Doctor of Philosophy and Medicine, Professor of Botany in the University and Polytechnicum of Zürich,
Director of the Botanical Garden, &c.

From the PHILOSOPHICAL TRANSACTIONS.—PART II. 1862.

LONDON:
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1863.

TO

MISS BURDETT COUTTS

THESE MEMOIRS,

RESULTS OF HER MUNIFICENT AND ENLIGHTENED

ENCOURAGEMENT OF SCIENCE,

ARE RESPECTFULLY DEDICATED BY

THE AUTHORS.

PREFATORY REMARKS.

THE precise chronological position of the lignite deposit at Bovey Tracey has long remained one of the most unsettled points in the geology of England. The memoirs here reproduced from the Philosophical Transactions, furnish, it is believed, more definite and satisfactory data for the solution of the problem than have been heretofore available.

Professor HEER's memoir is reprinted textually in the form in which it was communicated to the Royal Society; but as matter which is not original is excluded from the Philosophical Transactions, it has seemed advisable to add, as prefatory, such historical and illustrative details, necessarily omitted in the descriptive and stratigraphical memoir, as are calculated to render the present reprint, in some measure, a monographic account of the Bovey formation.

This deposit first became the subject of scientific inquiry upwards of a century ago. In 1760, a letter, addressed to the Earl of MACCLESFIELD, entitled "Researches on Bovey Coal," by the Rev. Dr. JEREMIAH MILLES, was read before the Royal Society and printed in the Philosophical Transactions, vol. li. Part II. p. 534, &c.

From this communication it would appear that the lignite was discovered about the year 1745. We shall see hereafter, however, that it must have been known much earlier. According to Dr. MILLES, the coal strata reached to within a foot of the surface, under a sharp white sand mixed with ash-colour clay, and dipped southwards about 20 inches to the fathom; there were six beds of coal alternating with as many of clay, the aggregate thickness being about 70 feet. In the upper part, the beds of clay and lignite were about equally thick, and varied from 18 inches to 4 feet; the lower beds of the latter were thicker, whilst those of the former were correspondingly thinner. The lowermost stratum of lignite was 16 feet thick; it lay on a bed of clay, beneath which was a bed of sharp greensand, not unlike sea-sand, 17 feet in thickness; and under this was a bed of coarse clay, which had been bored but yielded no coal. A spring of clear blue water, called by the workmen mundic water, arose from the sand. Amongst the clay, but adhering to the veins of coal, were found lumps of a bright yellow substance, extremely light, which burnt like sealing-wax and emitted a very agreeable aromatic odour. Dr. MILLES believed this to be "loam saturated with petroleum."

Three distinct kinds of "coal" were recognized, namely: 1st. That having a "laminous" texture, the laminæ running in such oblique, waving, and undulating forms as to bear a strong resemblance to the roots of trees. This was known as "*Root* coal." 2nd. A black, compact, solid and comparatively heavy and bituminous variety; distinguished by the name of "*Stone* coal," from its resemblance to ordinary coal. It produced a stronger and more lasting fire than the other kinds. 3rd. "*Wood*" or "*Board* coal;" so called from its having the "appearance of deal boards." It occurred in pieces 3 or 4 feet long, and even longer; it was of a chocolate colour or shining black; very elastic when first dry, but exposure to the air deprived it of this quality and rendered it quite crisp and short; it easily separated into laminæ, especially after exposure to the sun. Pieces of spar were occasionally found in the middle of this variety.

When put into the fire, the "Coal" was found to crackle, to separate into laminæ and irregular pieces, to burn for some time with a heavy flame, become red-hot, and gradually consume into white ashes; if quenched when red-hot it did not look like charcoal. It gave out a thick heavy smoke and a disagreeable fetid odour, much resembling that of the asphaltum of the Dead Sea.

Dr. MILLES subjected the lignite to analysis; and, from one pound of the "Woody" kind, obtained four ounces and a half of water having a bituminous smell and taste, nearly four ounces of a turbid, whitish, bituminous liquor, of an intolerable fetid smell and extremely pungent to the tongue, about two drachms of a heavy bituminous matter which would not mix with the former liquor, but sank to the bottom, and about seven ounces of a very black powder which had the same bituminous smell. The ashes of the lignite yielded no salt on being boiled in water.

The principal aim of this author was to prove the *mineral* origin of the lignite, in refutation of Professor HOLLMAN of Göttingen, who, in a paper previously presented to the Royal Society of London, and printed also in the Philosophical Transactions, vol. li. Part II. p. 506, &c., had assigned a *vegetable* origin to the "Fossil Wood" found near the city of Munden and elsewhere in continental Europe, and which was believed to correspond in many particulars to the Bovey coal. Dr. MILLES contended that the great quantity of the lignite, the firmness of the accompanying soil, the regularity of the stratification, the flatness of the "*Wood* Coal," the absence (as he believed) of all signs of roots, branches, bark, round pieces, and concentric year circles, its defective combustibility as compared with that of wood, the products obtained by analysis, and their behaviour under chemical treatment conclusively proved that it differed from all known wood and was "an actual mineral substance." Consistently with this view, he held that certain "small protuberances like knots of trees" (which they no doubt were), which sometimes appeared on the "*Wood* Coal," were only mineral nuclei.

This drew forth a series of papers on the subject from Professor HOLLMAN; so that the controversy was kept before the scientific world for upwards of twenty years*. It appears to have been all but fatal to the *mineral* theory, as no writer on the lignite, subsequent to Dr. MILLES, seems to have adopted it, though, as we shall see, some of them thought it required, and was worthy of, refutation. It still maintains a humble existence, however, amongst the workmen, who seem reluctant to allow it to die.

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* PARKINSON'S 'Organic Remains,' vol. i. Letter XI., p. 120, &c.

The third part of Mr. Kirwan's 'Elements of Mineralogy,' published in 1794, is devoted to "Inflammables." In his fourth genus of this class, the author placed "Vegeto-Carbonated Substances"—his first species being "Carbonated Wood," which he divided into three varieties, namely, "Ligniform," "Scaly or Earthy," and "Compact." The first includes the *Surturbrand* of Iceland, and the last the *Piligno* of the Italians, and *Bovey Coal*; the specific gravity of which he fixed at from 1·4 to 1·558, and added that Mr. Fabroni discovered its organic structure by boiling it in dilute nitrous acid, its fibres being thereby laid bare, and that this species of coal is "nothing else but wood whose oil has undergone a change of the putrefactive kind"*.

Dr. Maton's 'Observations on the Western Counties of England, made in the years 1794 and 1796,' contain some particulars respecting the Bovey deposit. Though this author had evidently visited the district, his description appears to be mainly a copy of that given by Dr. Milles. He adds that the pits were of considerable service to a pottery close by; that they were often filled with water to the height of 40 feet or more, which was carried off by machinery; that an ochreous sediment was found in the water; that a large turf bog existed at a short distance from the pit, where decayed roots and, indeed, whole trees were often discovered, none of which bore the least resemblance to the "Coal"; and that he had found exactly the same substance as the lignite, at a depth of several feet, in blackish clay near Shotover Hill in Oxfordshire. On this last point, Professor Phillips obligingly informs me that "no doubt it was *jet* which Dr. Maton saw in our Kimmeridge clay. There is no Cainozoic deposit like that of Bovey in the neighbourhood of Oxford."

The arithmetic of the formation given by Dr. Milles, and copied *verbatim* by Dr. Maton, differs somewhat from that obtained from the present excavation. The *Dip*, southwards as now, was "twenty inches to the fathom," or about 15½° instead of 12½°; and the strata were fewer and thicker. It is possible that thin layers of dark clay, separating coal strata, were sometimes disregarded, and the whole measured as one bed. Probably, also, only those beds of lignite which were thick enough, or of sufficiently good quality to pay for working were registered. Moreover the early workings were at some distance from the present pit; so that the sections described by the first observers are no longer visible, it having been the practice formerly, as it is still by the *clay*-diggers, to re-fill abandoned excavations with the refuse of new ones. The small number of beds, however, was mainly due to the fact that (as we shall hereafter see) the lower lignite series had not then been discovered.

In 1797, a paper entitled "Observations on Bituminous Substances, with a Description of the Varieties of the Elastic Bitumen. By Charles Hatchett, Esq., F.R.S. Lond. and Edinb., F.L.S. &c.," was read before the Linnean Society and printed in the 'Transactions' of that Body, vol. iv. p. 129, &c. Under the head of "Bituminous Wood," the author described the characters and situation of the Bovey "Coal,"—stating that the first stratum commenced at about 6 feet below the surface, the overlying mass being a pale brownish clay mixed with quartz pebbles; that there were seventeen strata, the thickest being from 6 to 8 feet; that the lowest beds, and the most southerly portions of them, produced the best "coal," which burnt readily, with a flame like half-charred wood, did not crackle, and, if but moderately burned, formed charcoal, or if completely burned left a small quantity of white ashes exactly similar to those of wood; that the strata exhibited none of those irregularities on the surface which might be expected on the supposition that they were formed by the roots, trunks, and branches of trees long buried in the earth; that it was difficult to imagine wood to have been transported and deposited in the same place at seventeen different periods, whilst it must be allowed that the strata had been formed by successive operations; and that, though he had twice visited and examined the spot expressly for the purpose, he still found himself utterly unable to offer any opinion on the subject. He was, nevertheless, quite satisfied that the "coal" is of vegetable origin; and stated that, though it resembled half-charred wood and was in a condition nearly similar, it did not follow that fire had been the cause; he was inclined rather to attribute it to changes produced in the original vegetables in the progress of putrefaction; and he regarded the oily and bituminous matter, which he had obtained from the "coal" by distillation, as the remainder of the vegetable oils and juices, which had been partly modified by mineral agents.

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* Elements of Mineralogy, vol. ii. p. 60, &c.

On comparing this description with that of Dr. Milles, a few points of difference are noticeable. The beds recognized by the later author were more numerous and thinner, and the uppermost was *six* feet below the surface, instead of *one* foot; in fact the figures approximate those of the present pit sections. The apparent discrepancies probably arose from the discovery of the lower series of lignites and the change in the situation of the excavation. The number of the beds, however, though nearly three times as great as that recorded by Dr. Milles, is but little more than half that given in "Section 1" of the late explorations—seventeen instead of thirty-one (see page 4, &c.). This difference may be, perhaps, explained away in the manner previously hinted.

Again, Dr. Milles stated that, during combustion, the "coal" crackled, and that, on being partially burnt, it did not assume the character of charcoal; whilst, according to Mr. Hatchett, it did *not* crackle, and *did* form charcoal. On both points modern experience confirms the statements of the latter.

Mr. Brice, in his 'History and Description, Ancient and Modern, of the City of Exeter,' published in 1802, gave a somewhat minute account of the formation. He attributed the broken features and surface inequalities of the Bovey plain to "ancient stream-works of the tinners"; and stated that the lignite was taken from an extensive open mine of easy descent for horses to bring up its contents; that the strata run nine miles to the southward through the Heathfield, Knighton, Teigngrace, and Newton Marshes to Aller; and that the "mundic water" mentioned by Dr. Milles was said to abound in sulphur and vitriol, and was as warm as some of the Bath springs. He discussed the question of the vegetable or mineral origin of the lignite, deciding in favour of the former, which seems to have been the prevalent opinion at that time, as he stated that "the basis of the Bovey 'coal' is *generally supposed to be* vast assemblages of trees that have, in various and distant ages, been washed by torrents from the neighbouring hills, and on which, from time to time, the intervening beds of clay have been deposited," and added, what he supposed to be a confirmatory fact, that "the people of Bovey have a number of railing-posts formed of the fossil." On this last point he was certainly in error; no sample of lignite was ever found suitable for such a purpose. There can be no doubt that the "railing-posts" were made out of trees found in the bog first mentioned by Dr. Maton. In this view I am confirmed by Dr. Haydon of Bovey, who, in a letter to me on the subject, says, "There is a gentleman residing here who remembers post-and-railing in his father's garden, in this place, made from *bog-wood* raised on the Heathfield by his grandfather. He says it was *Fir*, of a dark colour, and burnt as a torch when lighted." Mr. Brice supposed it very probable that the Heathfield might have once been a deep morass or stagnant lake, into which the wood was transported from the neighbouring hills; he also held that stagnant water of this kind would be unfavourable to animal life, and that the more tender vegetables would be destroyed before the wood could assume a sufficient consistence to receive and retain their traces; hence the alleged "absence of vegetable and animal impressions." It does not appear to have occurred to him that this would fail to account for the absence of leaves, dead shells, &c. carried into the lake.

Like Dr. Milles and Dr. Maton, Mr. Brice stated, almost in the exact words of the first, that "the lowest stratum of lignite reposed on clay, under which was a sharp green sand, like sea-sand, 17 feet thick, and beneath this a compact clay not yet perforated by the borer." Hence it would appear that the lowest lignite series had not been discovered in 1802; for the beds here specified are evidently the 25th, 26th, 27th, 28th, and (perhaps) 29th of the present pit section (see page 5)—that is, the basement beds of the upper lignite division. Mr. Hatchett's mention, however, of "seventeen beds" shows that the lowest series was known to him in 1797. On the whole, then, it appears that the lowest division of lignite was certainly not known in 1760, probably not in 1794, but had been discovered in 1797; that Mr. Brice did not publish his 'History of Exeter' until some years after his visit to Bovey, or that he adopted what, in the altered state of the excavation, had become the inaccurate description of Dr. Milles. From internal evidence I incline to the latter alternative.

Mr. Parkinson devoted the 11th letter of the first volume of his 'Organic Remains' (published in 1804) to lignite and kindred substances, and gave a description of the Bovey beds in Dr. Milles's "own words." Accordingly he followed that author in the statement, equivalent to that just quoted from Mr. Brice, respecting beds of sand and clay below the "*lowest* stratum of lignite," and, almost immediately, added—"beneath this was an equal, if not greater, quantity of fossil wood." This, though given as part of Dr. Milles's account, does not occur in the original; indeed it manifestly contradicts the statement which precedes it. The lowest series having been discovered, the passage was, of course, required; it is nevertheless an interpolation, and, as such, proves that the compiler of the letter also understood the lowest strata known to Dr. MILLES to be the basement beds of the upper lignite series.

The 12th letter of the well-known work just mentioned, is by Mr. ROBERT SCAMMELL of Bovey, and is entitled "Particulars respecting Bovey Coal, dug at Bovey near Chudleigh, Devonshire." The writer gave a section of the beds, accompanied by a Table, from which it appears that the thickest measured 5 feet 6 inches, the thinnest 4 inches, and that the average of all those worked was about 19 inches. The lowest was known as the "Last" bed, and was probably identical with that bearing the same designation at present. He stated that the "coal" beds had been *worked* about ninety years, or as early as 1714; that is, upwards of thirty years before the date of their *discovery* according to Dr. MILLES; that the ground broken for the workings during that time amounted to ten acres; that exposure, for even seven years, to the sun and atmosphere failed to deprive the lignite entirely of the disagreeable odour it gave out when burning, which was found to be injurious to the health of the inhabitants; that the dip of the strata was about one in six, or 10°; that no leaves, pine-nuts, or anything having a vegetable form had ever been discovered either in the lignite or incumbent strata; and that trees of the fir kind, together with pine-nuts, but no "coal," had been met with in the bog near the pit.

In the same year (1804) a paper by Mr. CHARLES HATCHETT, under the title of "Observations on the Change of some of the Proximate Principles of Vegetables into Bitumen, with Analytical Experiments on a Peculiar Substance which is found with the Bovey Coal," was read before the Royal Society, and printed in the Philosophical Transactions for that year, Part I. p. 396. It described an elaborate and extensive series of chemical experiments, made by the author, on the Bovey "coal" and the Surturbrand of Iceland; from which it appeared that 200 grains of the lignite yielded, by distillation,

	grs.
Water	60
Thick brown oily bitumen	21
Charcoal	90
Mixed gases—hydrogen, carbonated hydrogen, and carbonic acid	29
	200

that the ashes obtained from the charcoal afforded no trace of alkali; that the Bovey "coal" (unlike the Surturbrand in this respect only) yielded no signs of vegetable extract; that a small portion of true resin (about 3 grains in 200 of "coal") still remained inherent in the wood, though the bituminous part was by much the most prevalent and caused the fetid odour which attended its combustion; and that the lignite consisted of woody fibre in a state of semicarbonization, impregnated with bitumen and a small portion of resin.

The "peculiar substance" mentioned in the title of this paper, was that noticed by Dr. **Milles** as "a bright yellow substance found adhering to the coal," which he believed to be "loam saturated with petroleum." Mr. **Hatchett** found that 100 grains of it yielded resin 55 grains, asphaltum 41 grains, and earthy residuum 3 grains. He described it as a peculiar and hitherto unknown substance, and proposed "*Retinasphaltum*" for its name, as expressive of its composition.

The flatness of the "Board coal" he thought was not improbably attributable to a certain change in the solidity of the vegetable bodies, to some superincumbent pressure, and to a powerful mechanical action exerted by the argillaceous strata in consequence of desiccation. The state of the clays at Bovey, however, by no means warrants the opinion that they have undergone much, if any, desiccation; hence it seems necessary to attribute to superincumbent pressure a correspondingly greater share in the production of the flattened form.

The deposit seems to have been next noticed by Mr. **Charles Vancouver**, in his 'General View of the Agriculture of the County of Devon,' published in 1808. He added but little, by his facts or speculations, to what was previously known on the subject. His opinion was, that clay and other moveable matter must have been poured in a fluid state, and at different periods, from the craggy eminences around, over the pine-forests which heretofore, and at remote distances of time, grew in the valley; and that the wood found in the bog is of the same character as the lignite, which, he says, "is generally composed of the roots and trunks of *Pinus sylvestris*."

In 1814, Dr. J. **M^cCulloch** read a paper before the Geological Society of London, on "Certain Products obtained in the Distillation of Wood, with some account of Bituminous Substances, and Remarks on Coal," which was printed in the 'Transactions of the Geological Society,' First Series, vol. ii. p. 1, &c. One of the author's aims appears to have been to prove that, on examining the alteration produced by water on common turf or submerged wood, we have all the evidence of demonstration that its action is sufficient to convert them into substances capable of yielding bitumen on distillation. That the same action, having operated during a longer period, had produced the brown "coal" of Bovey is rendered extremely probable "by the geognostic relations of that coal." He regarded the resin "of this wood" (probably the "*retinasphaltum*" of Mr. **Hatchett**, since he speaks of it as that "on which a peculiar name has lately been bestowed") as "an adventitious and accidental substance, the natural produce of the tree, now probably unknown, which occupies these alluvial strata."

The description of the Bovey beds in **Lyson's** 'Magna Britannica,' vol. vi., "Devonshire," p. ccxlix, published in 1822, was compiled from the works, already noticed, of Dr. **Maton** and Mr. **Vancouver**,—the author adding that the overlying clays and gravel were "undoubtedly derived from the high lands of Dartmoor."

In the 'Outlines of the Geology of England and Wales,' by **Conybeare** and **Phillips**, which also appeared in 1822, the Bovey plain was spoken of as having once been an estuary, and the beds of vegetable matter as derived from drift wood, which had floated in, became saturated with water, and perhaps covered by alluvial débris drifted on its surface by the wintry torrents, and thus sunk. The interstratified beds were considered to be the alluvial débris of granitic rocks.

The "Third Book" of this well-known work, chiefly written by the Rev. W. D. CONYBEARE, is occupied with the rocks of the "Carboniferous Order." In the second section of the first chapter, the author took a brief view of the several geological localities in which substances identical with coal, or in a high degree analogous to it, occur, and stated that they range through the whole suite of formations. In his enumeration, he began with the most recent; and, disposing of the "*Alluvial*;" as belonging to an order of causes still in action, passed on to the "*Diluvial*"—defining it as "*associated with accumulations of gravel apparently resulting from the last great catastrophe that has affected the earth's surface, but unconnected with the order of causes still acting*;" and here he placed the Bovey beds, with the remark that they afford an excellent example of the *Diluvial* deposit. This appears to have been the first attempt to deal with the chronology of the formation.

The 'Teignmouth Guide,' in two volumes, by Dr. TURTON and Mr. J. F. KINGSTON, is without date; it was published, it is believed, about 1832 or 1833. The second volume contains the Natural History of the neighbourhood. In the geological notices, the author, Mr. KINGSTON, made some mention of the Bovey beds, giving full descriptions of the various marketable clays found in different parts of the basin. He thought it not improbable that diluvial action might have destroyed and drifted some ancient forest, then existent in the vicinity, to its present situation, under the débris of the rock-strata through what may previously have been an inland lake.

In a copy of the 'Guide' in the Library of the Devon and Exeter Institution, there is a manuscript interlineation by Mr. KINGSTON, to the effect that the deposit is "probably a tertiary formation of the older Pliocene period." I have not been able to ascertain at what date this was inserted.

It does not appear that Mr. GODWIN-AUSTEN, in either of his papers, more than incidentally mentioned the lignites and associated beds of the Bovey basin; this is much to be regretted, as probably no one is better acquainted with the geology of that part of Devonshire immediately under consideration. In his memoir in the 'Transactions of the Geological Society,' 2nd Series, vol. vi. part 2. p. 433, &c., on "The Geology of the South-East of Devonshire" (containing, in a condensed form, the substance of papers read before the Geological Society in 1834 and subsequently), he recorded some facts respecting the overlying "Head." The second division of the "Memoir" is devoted to the "*Period prior to the most recent changes of relative level of land and water, and of climate*"; in the fourth section of this division the author treated of "*Ancient lacustrine deposits*," regarding the Bovey plain as an ancient lake. He stated that the "Head" consists, in some places, of horizontal layers of sand—coarser beds, often 30 feet thick, occurring chiefly on the north-eastern side; that bones of the wild boar, ox, and red deer (black and having a smooth polished surface) are found in, and beds of peat occasionally beneath it; and that the subangular and flattened form of the materials, as well as their arrangement, show them to be of lacustrine origin.

Subsequently, when treating of "*Gravels*," in his third division (that in which he described the "Tertiary Deposits" of the district) he mentioned a bed of considerable thickness, of purely cretaceous materials, which "corresponds exactly with those beds which, in many places, constitute the lowest tertiary deposits, where they rest on chalk," and added that "in the Bovey valley a similar accumulation is subjacent to the pipeclay beds." Here, then, we have a chronological opinion, though by no means a definite one. It amounts to this: the Bovey formation is more modern than the lowest tertiary deposits; and the gravels or "Head" overlying it more ancient than the most recent changes of relative level of land and water, and of climate. It does not clearly appear that this author separated the "Head" chronologically from the beds beneath.

The late Sir H. DE LA BECHE, in his 'Report on the Geology of Cornwall, Devon, &c.,' published in 1839, stated that, with the exception of the lignite itself, no organic remains had been found in the Bovey deposit; so that its age remained undetermined further than that, if, as had been supposed, the lignite belonged to oak and other existing trees, the beds might have been formed towards the latter part of the supracretaceous period. He thought it possible that we might now merely have in the Bovey depression the lowest parts of a considerable and more widely distributed deposit which overspread the country; for clays and sands, apparently continuous portions of the Bovey beds, are found occupying far greater elevations than in the vale beneath.

I am inclined to doubt whether this distinguished author ever recognized the fact that the "Head" and the lignite belong to two different periods. The "clays and sands, occupying greater elevations," have all the characters, positive and negative, of the former, but not of the latter. The same doubt is suggested by his reasoning on the supposition that "the lignite belonged to oak and other existing trees." The clay-diggers not unfrequently find roots and portions of trunks, which *they*, perhaps correctly, suppose to be oak, in the "Head"; and the Scotch fir and "other existing trees" have been taken out of the adjacent bog; but none of these have been found in the lignite series.

In a paper "On the Ultimate Analysis of some Varieties of Coal," by FRED. VAUX, Esq., published in the Quarterly Journal of the Chemical Society of London, vol. i. p. 318, &c. (1849), it is stated that the Bovey "Coal" becomes quite rotten after immersion in water; that it does not soil the fingers; that the coke has a semimetallic lustre, does not swell, cakes but slightly, and does not take the form of the crucible; that it is easily converted into a bulky red ash interspersed with filaments; that before the blowpipe it is partially, but with difficulty, fusible into a black clinker; and that its composition, &c. is as shown in the following Table:—

Relative Proportions in 100 *parts of Bovey Lignite.* Specific gravity 1·129.

		Free from Water and Ash.	
Carbon	66·314	Carbon	67·8535
Hydrogen	5·627	Hydrogen	5·7576
Oxygen	22·861	Oxygen	23·3920
Nitrogen	0·565	Nitrogen	0·5781
Sulphur	2·364	Sulphur	2·4188
Ash	2·269		
Water	34·660		
Coke	30·799		

Copper and lead were detected in the ash.

The coal must have been worked, according to Mr. SCAMMELL's dates, nearly a century and a half, it had been brought under the notice of four learned societies, and had been described by no fewer than fourteen authors, some of whom had, more than once, visited the locality for the purpose of carefully examining the deposit, before any one succeeded in finding an identifiable fossil in it. It was not until 1855 that Dr. HOOKER, by reading a paper before the Geological Society of London, "On some Small Seed-vessels (*Folliculites minutulus*) from the Bovey Coal," first publicly announced to the scientific world that the spell had been broken by the discovery and identification of a fossil there. This paper was printed in the 'Quarterly Journal of the Geological Society,' vol. xi. p. 566, &c.

In his description of the deposit, Dr. HOOKER stated that the bed of peat, so frequently mentioned, contained trunks of trees not now found in the immediate neighbourhood, but which appeared to agree in microscopical character with the common maple (*Acer campestre*); that they were quite fresh and white, and lay in immediate contact with the surface of the uppermost bed of lignite; that in the upper layers of lignite was found a cone (wholly carbonized and the woody interior of its scales and axis highly bituminized) in no way distinguishable from that of a Scotch fir, and which had, accordingly, been provisionally referred to that species; that this determination seemed to assign the formation to the Postpliocene epoch; that a microscopical analysis of the wood-cells of the cone disclosed no reason to doubt that it belonged to the species that yielded the coniferous wood of the lignite with which it was associated; and that no character of the wood prevented its belonging to the Scotch fir. The fossil "seed-vessels" named in the title of the paper were described as occurring in the lowermost beds of lignite.

In the following year (1856) a paper "On the Lignite Deposits of Bovey Tracey, Devonshire," by Dr. J. G. CROKER, was read before the Geological Society, and published in the Quarterly Journal of that body, vol. xii. p. 354. In this communication the author spoke of *cones* (not a solitary specimen) referable to the Scotch fir, having been found in one of the uppermost layers of loose lignite; of fragments, sometimes 2 feet long and 20 inches wide, of large flabelliform leaves occurring in some of the higher beds, together with tangled masses of vegetable remains; and of the Bovey basin having been almost a swamp until it was drained "within the last ninety years." In letters which I received from Dr. CROKER, quite as early as the date of his paper, he mentioned that he had recognized ferns in the "tangled mass of vegetable remains." He made no attempt at specific or even generic determinations.

The fir-cones mentioned in the two papers just noticed are so important in their chronological indications (pointing, as they do, to a conclusion so very dissimilar to that to which the late explorations have led), that a few remarks on them seem called for. There can be no question as to the correctness of the determination. No one doubts that they belong to *Pinus sylvestris*. But is it equally certain that they were associated with the lignite? May they not have belonged to the bog, and therefore to the period represented by the "Head," or to one still more modern? Dr. HOOKER, who stated that he received his specimen, as well as the information respecting its situation, from Dr. CROKER, informed us that it was found *in the upper layers of lignite*; whilst, according to the latter author, writing a year afterwards when other specimens had been met with, it was in *one of the uppermost layers.* We shall probably not be wrong if we suppose it to have been *the* uppermost layer. Now, as has been already mentioned, Dr. HOOKER stated that the trees found in the bed of peat *lay in immediate contact with the surface of the uppermost bed of lignite.* There is little difficulty, then, under the present hypothesis, in believing that objects really belonging to the peat had been supposed to belong to the lignite *in immediate contact with it*; and this difficulty, if there be one, is diminished by the consideration that the cones were probably found, not by Dr. CROKER himself, but by ordinary workmen, totally unaccustomed to scientific observation, who handed them to him. Moreover, according to Mr. SCAMMELL, "many trees of the fir kind, *together with pine-nuts*" (fir-cones I presume), had been taken out of the bog. But the bog trees mentioned by Dr. HOOKER were "quite fresh and white," whilst the cone was "wholly carbonized and the woody interior of its scales and axis highly bituminized." The trees, however, which are taken from the peat are not always thus unchanged; Mr. ROBERT FRENCH, now living at Bovey, states that the tree taken up by his grandfather "*was of a dark brown colour like cedar, and burnt as a torch when lighted.*" On the whole, I have no doubt that the cones came from the bog, not from the lignite.

The foregoing summary includes, so far as I have been able to ascertain, the substance of all that had been written respecting the Bovey formation prior to the commencement of the late exploration in the year 1860, and shows the position of the inquiry at that date.

The following Table, from Dr. PERCY's 'Metallurgy,' page 214 (1861), shows the composition of the clay dug in various parts of the Bovey basin, and which, from the port at which it is shipped, is sometimes termed "Teignmouth Clay."

Silica	52·06
Alumina	29·38
Potassa	2·29
Lime	0·43
Magnesia	0·02
Protoxide of iron	2·37
Water, combined	10·27
Water, hygroscopic	2·56

Shortly after the papers by Professor Heer and myself were presented to the Royal Society, a memoir "On the Bovey Deposit," by J. H. Key, Esq., was read before the Geological Society of London, in which the author gave descriptions and sections of the strata (especially indicating their characters and succession from Knighton to Newton on the eastern side of the basin, at the Decoy, and at Aller), showed that the detrital matter was derived from Dartmoor, speculated on the deposition of the beds and the course by which the surplus water of the ancient lake passed to the ocean, and mentioned a deposit on the northern slope of Dartmoor which much resembled that at Bovey*.

At some parts of the workings the lignite is so firm, compact, and tough that it can only be removed by blasting; at others it is extracted without difficulty, or is even loose and brittle. Occasionally, though apparently of great firmness, large slabs fall from the top (locally "back") and sides of the tunnels, not, however, without giving timely warning in the shape of a smart crackling noise.

In some parts of the western tunnel (see page 2) the drip of water is very considerable, amounting, indeed, in a few instances to a continuous and rather copious flow, which seems somewhat increased after heavy rains. In other parts the same tunnel is quite dry, as, for example, at and near its present western extremity. The water is taken out of the pit by pumps set in motion by a large water-wheel, which is also employed to draw up the lignite, as well as "refuse," by means of an inclined plane at the eastern end of the pit.

In 1859, the "coal" in one of the old tunnels was found to be on fire—ignited, it is believed, by burning cinders from the refuse of an adjacent brick-kiln having accidentally found their way into it. After various unsuccessful attempts to put it out, it became necessary to discontinue the works, in order that the water might accumulate sufficiently to extinguish it. In the spring of 1860, Sir Charles Lyell and Dr. Falconer found fully 30 feet of water in the pit, and learned from Mr. Divett that he had no intention of pumping it out; fortunately, however, the proprietor changed his mind soon after we began our investigations; and as we descended with our section, we had the gratification of seeing the water steadily retreating before us, so that the lowest beds were exposed some time before we reached them.

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* Quart. Journ. Geol. Soc. vol. xviii. p. 9, &c.

In consequence of the works having been suspended, as just mentioned, ordinary "sea-borne" coal was exclusively employed at the pottery, and at present but little lignite is used there. It can be rendered at the surface at the pit for about five shillings per ton, but on account of its offensive odour it is not in much demand. Under careful management, it is estimated that about six tons of it will produce the heat of one ton of ordinary coal.

In the innermost ninety fathoms of the only "working" in which coal is now extracted, that is from 100 to 190 fathoms from the mouth of the tunnel, the workmen sometimes find the atmosphere oppressively foul, and have much difficulty in keeping their candles burning. This is especially noticeable with an easterly wind, which, by blowing *directly* in, appears to check the ventilation.

The men also speak of the high temperature at this part. At 3 P.M., October 30th, 1861, I found it 61° Fahr. in a dry situation at the inner end of the tunnel 60 fathoms from the workmen, and 56° in a sheltered spot, on the same level, at its mouth.

On account of the iron pyrites it contains, as well as the rapidity of its desiccation, it has always been very difficult to preserve specimens of the lignite; it was consequently feared that the large collection of fossils recently made would soon perish, or become valueless. But, acting on a suggestion of Dr. PERCY, I steeped them all in gelatine, which, though it may not have rendered them imperishable, has certainly retarded their destruction.

Though, when the memoirs here reprinted were presented to the Royal Society, the Bovey and the Hempstead series were placed on the same horizon (see page 18), it was not because any fossils were known to be common to the two, but simply on the ground that each was contemporary with the Lower Miocene deposits of the Continent. Since that period ten species of Lower Miocene plant-remains have been found at Hempstead, and determined by Professor HEER. Of these, four are identical with Bovey forms, namely, *Sequoia Couttsiæ*, HEER, *Andromeda reticulata*, ETTIN., *Nymphæa Doris*, HEER, and *Carpolithes Websteri*, BRONGN.*

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* Quart. Journ. Geol. Soc. vol. xviii. p. 369.

WILLIAM PENGELLY.

Lamorna, Torquay.

The Lignites and Clays of Bovey Tracey, Devonshire.

By WILLIAM PENGELLY, *F.G.S.* *Communicated by Sir* CHARLES LYELL, *F.R.S.*

Received November 16,—Read November 21, 1861.

THE little town or village of Bovey Tracey, in Devonshire, nestles at the foot of Dartmoor, very near its north-eastern extremity; it is situated on the left bank of the river Bovey, about two miles and a half above the point at which it falls into the Teign, and is about eleven miles from each of the towns Exeter, Torquay, and Totnes*,—bearing south-westerly from the first, north-westerly from the second, and northerly from the last.

A considerable plain stretches away from it in a south-easterly direction, having a length of six miles from a point about a mile west of Bovey to another nearly as far east of Newton; its greatest breadth, from Chudleigh Bridge on the north-east to Blackpool on the south-west, is four miles. It forms a lake-like expansion of the valleys of the Teign and Bovey rivers, especially the latter, whose course it may be said to follow in the higher part, where it is most fully developed; whilst the Teign constitutes its axis below the junction of the two streams. Its upper, or north-western portion, immediately adjacent to the village, is known as "Bovey Heathfield," and measures about 700 acres.

On its west and north-west, rise the lofty granite hills of Dartmoor, with their border of metamorphic rocks; on the north, the trappean elevations of Hennock; on the north-east and east, the Greensands of the Haldons, and the traps and limestones of the Chudleigh and Kingsteignton districts; and on the south, the traps, Devonian limestones, and associated rocks extending from Newton towards Ashburton†.

Contrasted with this rugged and elevated country, the so-called "plain" is not without some claim to the appellation, though by no means characterized by evenness of surface.

Shafts and other excavations have shown that the deposits in this basin consist of an accumulation of coarse gravel (mixed with sand and clay), of variable thickness, unconformably covering distinct strata of lignite, clay, and sand, which are familiar to geologists as the "Bovey deposit," whilst the lignite is equally well known as "Bovey coal."

This deposit not only occupies the plain which has been described, but is continued, in a narrow southerly prolongation, from Newton to near Kingskerswill, about three and a half miles from Torbay. This entire prolongation is a divergence from the Teign. Where it crosses the estuary of that river it is about four miles from the coast.

The most important of the excavations is that known as the "Coal-pit," which is situated on the Heathfield, somewhat less than a mile south of the village, and about the same distance from the western margin of the deposit. It is open to the day, and is, in form, a rude parallelogram, having its longest side, about 960 feet, in the direction from S. 75° E. to N. 75° W., whilst the shortest measures 340 feet, and has a bearing of N. 35° E. to S. 35° W.[*] Its greatest depth, at the western end, is nearly 100 feet.

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* The distances throughout are measured in straight lines on the Ordnance Maps.

† See Map, Plate I.

Subterranean excavations have been carried on very extensively, in various directions, by means of tunnels opening out of the pit at its bottom. At present the working is confined to one tunnel, extending 190 fathoms, almost in a straight line, in the direction N. 65° W. from the western end of the pit.

The lignite was formerly used in large quantities in an adjoining pottery; at present but little is employed there, and its use is almost entirely confined to the poorer cottagers of the immediate district. A very offensive sulphurous smell, which it emits during combustion, prevents its general domestic use.

The refuse matter, consisting of clay and waste or valueless lignite, is lodged on the surface around the pit. Iron-pyrites occurs in it in considerable quantities; and spontaneous combustion is common in fresh refuse, especially after much rain. The fire is not generally visible near the surface in the day-time, but its presence is indicated by smoke and the very offensive odour previously mentioned. Cracks, having their sides lined with flowers of sulphur, cross the burning mass in various directions. Occasionally, crystals of sulphate of alumina are also formed.

The attention of both the scientific and the commercial world has long been called to this deposit; several accounts of it have been laid before various learned societies, and otherwise given to the world[†]. Many of these, besides descriptions of the characters and arrangement of the strata, contain speculations and discussions on various topics, especially the mineral or vegetable origin of the lignite, the mode in which the materials of the deposit were accumulated, and the place of the formation in the chronological series of the geologist. These may be said to have resulted in a settled conviction that the lignite is of vegetable origin, that the clays and sands had been furnished by the disintegration of the Dartmoor granite, and that the whole is of supracretaceous age—and a general belief that the plants had not grown on, but had been transported to, the area they now occupy. The exact chronology of the formation was by no means agreed on, further than that there seemed to be a prevalent but vague opinion that, geologically speaking, it was very modern. The only definite expression that had been given on the question was the provisional one that the deposit belonged to the Post-pliocene epoch; this was based on a cone said to have been found in one of the uppermost beds of lignite, and which was identified by Dr. HOOKER as belonging to the Scotch fir (*Pinus sylvestris*)*. This and some small seed-vessels, described by Dr. HOOKER under the name of *Folliculites minutulus*, were the only identifiable fossils which, prior to the late explorations, had been found at Bovey. Indeed, so recently as 1839, Sir H. DE LA BECHE stated that, "excepting the lignite itself, *no* organic remains had been found in the deposit"†. Many geologists, however, were unwilling to accept this chronology as conclusive, nor were they without hopes that, on a careful and thorough examination being made, the beds might be found to contain fuller and more reliable evidence on the question.

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[*] The bearings are in all cases magnetic when expressed, as above, with an appearance of numerical exactness.

[†] The following is a list of the principal writers on the Bovey beds:—

Rev. Dr. Jeremiah Milles, in the Philosophical Transactions, vol. li. Part II. p. 534, &c., in 1760.

Mr. Kirwan, in his 'Elements of Mineralogy,' vol. ii. p. 60, &c., published in 1794.

Dr. Maton, in his 'Observations on the Western Counties of England,' made in the years 1794 and 1796, vol. i. p. 106, &c.

Mr. Hatchett, in the Transactions of the Linnean Society, vol. iv. p. 129, &c., in 1797.

Mr. Brice, in his 'History and Description, Ancient and Modern, of the City of Exeter,' p. 141, &c., published in 1802.

Mr. Parkinson and Mr. Scammell, in Parkinson's 'Organic Remains,' vol. i. p. 104, &c., in 1804.

Mr. Hatchett, in the Philosophical Transactions, vol. for 1804, Part I. p. 396, &c.

Mr. Vancouver, in his 'Agriculture of the County of Devon,' p. 70, &c., published in 1808.

Dr. J. McCulloch, in the Transactions of the Geological Society, 1st Series, vol. ii. p. 1, &c., in 1814.

Rev. D. Lysons, in 'Magna Britannica,' vol. vi., "Devonshire," p. ccxlix, published in 1822.

Rev. W. D. Conybeare and Mr. W. Phillips, in the 'Outlines of the Geology of England and Wales,' pp. 328 and 364, published in 1822.

Mr. Kingston, in the 'Teignmouth Guide,' vol. ii., published about 1832 or 1833.

Mr. Godwin-Austen, in the Transactions of the Geological Society, 2nd Series, vol. vi. part 2, p. 439, &c., in 1834, and subsequently.

Sir H. De la Beche, in his 'Report of Cornwall, Devon, &c.' pp. 248, 255, 515, &c., in 1839.

Mr. F. Vaux, in Quart. Journ. Chem. Soc., London, vol. i. p. 318, &c., in 1849.

Dr. Hooker, in Quart. Journ. Geol. Soc. vol. xi. p. 566, &c., in 1855.

Dr. Croker, in Quart. Journ. Geol. Soc. vol. xii. p. 354, in 1856.

During the spring of 1860, Dr. FALCONER made several visits to Bovey and various localities in its neighbourhood where clay-works were, or had been, carried on. The result was a strong impression that the deposit would be found to belong to the Miocene period. In one of these visits he was accompanied by the Rev. R. EVEREST, F.G.S., and in another by Sir C. LYELL, when they had an opportunity of examining the large collection of specimens of the lignite made by the late Dr. CROKER. Soon afterwards Dr. FALCONER introduced the subject to Miss BURDETT COUTTS as one which, for the credit of British geology, it was eminently desirable to have very fully investigated. After a visit to the Bovey "Coal-pit," Miss COUTTS, with characteristic liberality, furnished me with means to undertake the work. I received the most prompt and cordial co-operation from the proprietor, JOHN DIVETT, Esq., and was so fortunate as to secure the services of Mr. H. KEEPING, the well-known fossil-collector, of the Isle of Wight.

The lignite-beds, having suffered less from the weather than the interstratified clays and sand, stand out in relief, like a series of rude mouldings, on the wall of the pit, especially on its southern side; so that it is not difficult to make out, in a rough way, the succession of the beds. Nevertheless the clay and sand have been so much washed over the surface of the wall that it is impossible to do more than this; hence it was decided to make a fresh section—in fact, to cut a series of steps, on a large scale, by which to descend the face of the artificial cliff from top to bottom, and thereby accomplish the double work of collecting fossils and disclosing the geology of the deposit.

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* Quart. Journ. Geol. Soc. vol. xi. p. 566, &c.

† Report of Cornwall, Devon, &c., p. 257.

As we descended, the thickness of each bed and the amount and direction of its *dip* were carefully measured; a sample, and when necessary more than one, of every bed was taken, each in a separate box, and every important fact, as to the character of the bed and the occurrence or not of fossils in it, was carefully noted. The mean of the several measurements, all very near the average, gave a *dip* of 12½° towards S. 35° W. (magn.).

The results of this systematic exploration are exhibited below.

Section 1, *of the Bovey Deposit, in the south wall of the "Coal-pit," near its western end. Dip* 12½° *towards S.* 35° *W.* (*magn.*).

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
1	7	6	7	6	Sandy Clay.—Contains a large number of angular and subangular stones, without anything like regularity in their arrangement. This is locally termed "The Head." The upper two inches is a peaty soil, also containing stones.
2	2	6	10	0	Clay.—Plastic. Contains a few fragments of lignite. The uppermost four and the lowest two inches are of a buff colour; the middle band dark, approaching to black.
3	6	3	16	3	Sand.—Quartzose, with a ferruginous clay at the base.
4	2	9	19	0	Clay.—The uppermost ten inches more or less dark, sometimes approaching to black, in colour.
5		7	19	7	Lignite.—Woody and brittle.
6		11	20	6	Clay.—Very dark. Contains much broken lignite.
7	1	3	21	9	Lignite.—In some places woody, in others a mass of *Sequoia Couttsiæ*, Heer, and fern débris.
8		5	22	2	Clay.—Dark. Some broken lignite. Graduates into sand at the base.
9	2	0	24	2	Sand.
10	2	0	26	2	Clay.—Tough. Light lead-colour. Contains lenticular patches of sand, and, at the base, much fragmentary lignite.
11		8	26	10	Sand.—Sometimes ferruginous; in some cases cemented into a coarse grit or very fine conglomerate.
12	2	6	29	4	Clay.—Light lead-colour in the upper part, darker towards the base. Contains fragments of lignite.
13	1	0	30	4	Lignite.—Woody, loose, very brittle. The bed ill-defined, graduating into clay at each surface.
14	2	9	33	1	Clay.—Sandy and brittle. Contains a few fragments of lignite near the base. The uppermost and lowest parts of the bed are dark, the middle lighter, in colour.
15		7	33	8	Lignite.—Woody, loose, and brittle.
16	4	0	37	8	Clay.—Rather light in colour towards the top. Contains two bands of almost continuous broken lignite, one twelve, the other thirty inches above the base, the uppermost being the least persistent. The clay is not laminated; it breaks into irregular-shaped fragments, generally quite angular and with plane faces.
17	1	5	39	1	Lignite.—The lowest part of this bed abounds, in some places, with dicotyledonous leaves; where they do not occur, the lignite is very woody.
18	2	9	41	10	Clay.—Not laminated. Light in colour. Contains fragments of lignite.

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
19	2	1	43	11	Lignite.—Contains much clay in almost continuous bands.
20	1	2	45	1	Clay.—Laminated. Brittle. Rich in fragments of lignite.
21	3	4	48	5	Lignite.—Hard. Brittle. Broken. Contains a few seeds.
22	2	0	50	5	Clay.—Dark. Rather brittle. Coarsely laminated.
23	1	0	51	5	Lignite.—Contains much clay.
24	1	0	52	5	Clay.—Dark. Brittle. Contains a few portions of lignite.
25	6	2	58	7	Lignite.—Contains patches of dark clay. Seeds, flat in form, occur in the uppermost portion. The base is commonly a mass of large leaf-like forms and fronds of ferns; the former are Dr. Croker's "flabelliform leaves"[*].
26	2	1	60	8	Clay.—Light drab colour. Extremely rich in fossil stems, leaves, and fruits of *Sequoia Couttsiæ*, seeds of various kinds, and dicotyledonous leaves. An almost continuous band of broken lignite occurs at the base of the bed.
27	11	1	71	9	Sand.—Quartzose. Very coarse in the uppermost part, but becomes gradually finer towards the base. Contains somewhat large lenticular patches of clay. Ferruginous stains and bands are common.
28	5	9	77	6	Clay.—Light colour. Near the top it is somewhat sandy.
29	3	2	80	8	Clay.—Dark. Contains a considerable number of fragments of lignite.
30	1	0	81	8	Lignite.—Rather brittle. Not very woody. Contains ferns.
31		8	82	4	Clay.—Very dark. Some broken lignite.
32		11	83	3	Lignite. Very woody, tough, and extremely hard.
33	2	2	85	5	Clay.—Dark lead-colour. Contains broken lignite.
34		10	86	3	Lignite.—Very woody and rather tough. Contains seeds.
35	2	2	88	5	Clay.—Dark lead-colour. Contains pieces of lignite lying at all angles to the plane of the bed.
36		1	88	6	Lignite.
37	1	11	90	5	Clay.—Very dark lead-colour. Very brittle. Rich in pieces of lignite; the thickness of the bed somewhat variable.
38		4	90	9	Lignite.—Woody, and rather tough.
39		10	91	7	Clay.—Readily falls into fragments, which generally have plane, but sometimes curved surfaces. Contains pieces of lignite.
40	1	0	92	7	Lignite.—This bed is very uniform in thickness, and well-defined at each surface. Very compact and rather tough. Contains a few seeds. One specimen of *Sequoia Couttsiæ* was found here.
41	1	6	94	1	Clay.—Dark. So brittle as to fall in pieces at the least touch. Contains pieces of lignite.
42		9	94	10	Lignite.—Extremely brittle. The bed is somewhat irregular in thickness and obscure in definition.
43		9	95	7	Clay.—Lead-colour.
44		6	96	1	Lignite.—Irregular in thickness. Occasionally intersected by veins of clay, commonly at right angles to the plane of the bed.
45		7	96	8	Clay.—Dark. Fragments of lignite very abundant.
46		9	97	5	Lignite.—Very compact and tough. Abounds in seeds.
47	1	4	98	9	Clay.—Dull lead-colour in the upper part, changing into a darker hue towards the base; the upper band is tougher than the lower; the latter contains many pieces of lignite.
48		7	99	4	Lignite.—Compact. Contains seeds, and a few young circinate fern-fronds.

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[*] Quart. Journ. Geol. Soc. vol. xii. p. 354.

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
49		10	100	2	Clay.—Rather light lead-colour. Somewhat tough. Contains pieces of lignite smaller than usual.
50	1	0	101	2	Lignite.—Compact. Very tough. Yields large slabs of "Board Coal"*.
51		9	101	11	Clay.—Very dark. Contains a few pieces of lignite.
52		3	102	2	Lignite.—Loose and soft.
53		7	102	9	Clay.—Brown. Pieces of lignite abundant in the upper part, less so towards the base.
54	2	3	105	0	Lignite.—Compact, tough, woody. Yields large slabs of "Board Coal" having a mottled appearance. Contains a few seeds.
55		10	105	10	Clay.—Very dark blue. Of resinous aspect. Contained a piece of lignite six feet long and two inches broad; smaller fragments rather numerous.
56	3	2	109	0	Lignite.—Very woody. Frequently has a "charred" appearance.
57		5	109	5	Clay.—Blue. Brittle.
58	1	8	111	1	Lignite.—Woody, "charred" and mottled. Contains a few seeds; none occur where the lignite appears "charred."
59		4	111	5	Clay.—Some parts blue, others dark drab.
60	1	8	113	1	Lignite.—Woody, hard, brittle. Has a fracture resembling that of ordinary coal. Contains seeds.
61		4	113	5	Clay.—Blue and dark drab.
62	2	4	115	9	Lignite.—This bed consists of two bands: the upper, nine inches thick, breaks into irregularly shaped "glassy" pieces; the lower is very hard, light-brown, less heavy than the lignite usually is, brittle, woody, and has a fracture resembling that of ordinary coal. This band contains seeds, none of which appear in the upper. The bands graduate into one another through a thin layer of "charred" lignite.
63		6	116	3	Clay.—Light lead-colour. Contains seeds, probably more than one species. One stem of *Sequoia Couttsiæ* was found here.
64	1	3	117	6	Lignite.—Very hard and compact; not quite so tough as some of the beds above it, but by no means brittle; possesses traces of the "charred" character.
65		3	117	9	Clay.—Lead-colour. Resinous in aspect. Contains numerous pieces of lignite.
66	1	4	119	1	Lignite.—In all respects like the 64th bed.
67		2	119	3	Clay.—Resinous appearance.
68	1	4	120	7	Lignite.—In all respects like the 64th and 66th beds.
69		2	120	9	Clay.—Very brittle, laminated, and resinous in aspect.
70		3	121	0	Lignite.
71		1	121	1	Clay.
72	4	0	125	1	Lignite.—Termed by the workmen the "Last Bed"†.

In order to ascertain whether the succession and characters of the beds are the same in other parts of the pit, two other sections were made, also in the southern wall, one about 460, and the other 680 feet eastward from the first. The results are given below.

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* So named from having an appearance resembling "deal boards."

† This section is exhibited in Plate II.

Section 2, *of the Bovey Deposit, in the south wall of the* "*Coal-pit,*" 460 *feet eastward from Section* 1. *Dip* 12½° *towards S.* 35° *W.* (*magn.*).

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
1	6	2	6	2	Sandy Clay.—With angular and subangular stones; the upper six inches peaty soil, in which the stones also occur.
2	4	10	11	0	Clay.—Contains some fragments of lignite.
3	7	10	18	10	Sand.—Quartzose and ferruginous.
4	10	5	29	3	Clay.—In some parts sandy and of a buff colour, in others dark with vegetable débris. Much fragmentary lignite.
5		9	30	0	Lignite.—Woody and brittle.
6	1	7	31	7	Clay.—Dull lead-colour.
7	1	5	33	0	Lignite.—A matted mass of débris of *Sequoia Couttsiæ* and ferns.
8	2	0	35	0	Clay.—Light drab. Roughly laminated. Contains broken lignite.
9					Do not occur in this section.
10					
11					
12	1	3	36	3	Clay.—In some parts black with vegetable matter, in others light drab; the former most prevalent.
13		4	36	7	Lignite.—Much broken.
14	2	1	38	8	Clay.—Light drab. Much broken lignite near the top.
15		6	39	2	Lignite.—More compact than in the higher beds.
16	2	2	41	4	Clay.—Dull lead-colour. Somewhat resinous aspect. Broken into fragments having more or less curved surfaces.
17	1	0	42	4	Lignite.—Contains dicotyledonous leaves.
18	1	9	44	1	Clay.—Dark drab colour. Much broken into angular fragments. Contains pieces of lignite.
19	1	2	45	3	Lignite.—Contains a considerable quantity of clay, in almost continuous bands.
20	1	2	46	5	Clay.—Rich in fragments of lignite.
21	2	5	48	10	Lignite.—Compact.
22	1	3	50	1	Clay.—Dull drab colour.
23		10	50	11	Lignite.—Much broken; the fragments having well-defined clay-stained surfaces.
24		9	51	8	Clay.—Light drab. Broken. Resinous in aspect.
25	5	10	57	6	Lignite.—Contains patches of clay. Ferns and the so-called "flabelliform leaves" occur near the base.
26	3	6	61	0	Clay.—Light drab. Rich in stems, leaves, and fruits of *Sequoia Couttsiæ*.
27	1	7	62	7	Sand.—Quartzose and ferruginous. Contains lenticular patches of clay.
28		6	63	1	Clay.—Light colour.
29	3	9	66	10	Clay.—Dark colour.

The nature of the ground prevented the second and third sections being satisfactorily continued below the 29th bed. There is reason to believe, however, that the still lower beds are uniform in character and order throughout the pit.

In the third section the materials comprising the various beds will be named without remark, since those which agree numerically agree very closely geologically.

Section 3, *of the Bovey Deposit, in the south wall of the "Coal-pit,"* 680 *feet eastward from Section* 1, *and* 220 *feet from Section* 2. *Dip* 12½° *towards S.* 35° *W. (magn.).*

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
1	10	9	10	9	Sandy Clay.—With angular and subangular stones.
2	1	0	11	9	Clay.
3	12	6	24	3	Sand.
4	2	0	26	3	Clay.
5		6	26	9	Lignite.
6	1	0	27	9	Clay.
7	1	9	29	6	Lignite.
8					Do not occur in this section.
9					
10					
11					
12	1	8	31	2	Clay.
13		10	32	0	Lignite.
14	2	4	34	4	Clay.
15	1	4	35	8	Lignite.
16	3	0	38	8	Clay.
17	2	0	40	8	Lignite.
18	2	0	42	8	Clay.
19	2	0	44	8	Lignite.
20		6	45	2	Clay.
21	3	1	48	3	Lignite.
22	1	0	49	3	Clay.
23		11	50	2	Lignite.
24		6	50	8	Clay.
25	5	3	55	11	Lignite.
26	3	2	59	1	Clay.
27		10	59	11	Sand.
28		7	60	6	Clay.
29	3	2	63	8	Clay.

On comparison, it will be found that the 9th, 10th, and 11th beds of Section 1—the first and last being sand and the second clay—do not occur in either of the other two sections, and that in Section 3 another clay-bed is also missing. This last is supposed to be the 8th, but it would probably be difficult to determine between it and the 12th. It is possible, moreover, that the bed numbered 12 in the third may represent both the 8th *and* 12th of the two other sections. The same numbering has been retained in all the sections to facilitate comparison.

The total thickness of the missing beds amounts to no more than about 5 feet; the fact, however, that they are not present may be significant. It amounts to this: by removing 460 feet further into the ancient Bovey lake (for such I assume the area to have been)—460 feet further from its ancient shore, that shore being the granitic region of Dartmoor,—we leave behind two thin beds of sand, which do not reappear when we advance 220 feet further in the same direction.

Eliminating these beds, we have no sand in the series below the uppermost bed of lignite (No. 5) excepting No. 27, which occurs in all the sections, and, indeed, constitutes a marked feature in the deposit as exposed at the "Coal-pit." It is 133 inches thick in the first section, no more than 19 in the second, and dwindles to 10 inches only in the third; but no bed is more continuous or better marked: its comparatively bright colour catches the eye, and indicates its presence along the entire length of the excavation. It attains a still greater thickness in the western wall of the pit. Between the first and third sections it forms an inclined plane 680 feet long and 123 inches high; or base : height $=8160:123=$ rad : tan $52'$; so that, great as the attenuation is, it merely produces a gradient of 1 in about 66, or an inclination of less than one degree.

The sections show that a similar eastward diminution of thickness characterizes the 28th bed.

This attenuation, like the thinning out of the beds previously mentioned, (which, it may not be out of place to remark, is in the direction of the *Strike* of the deposit,) is probably an indication, were one needed, that the detrital layers were formed at the expense of the Dartmoor granite.

The sections agree in naturally dividing themselves into three parts or series, viz.—

1st. The bed No. 1, of SANDY CLAY, containing angular and subangular stones.

No stones of any kind were met with below this.

2nd. The beds from the 2nd to the 27th, both inclusive, composed of sand, clay, and lignite.

3rd. All the beds below the 27th, consisting of clay and lignite only*.

It appears that that portion of the age of the deposit, which is represented by the first (that is, lowest) forty-five beds was unmarked by the deposition of sand within that area. Forty-four beds of lignite and clay, having an aggregate thickness of upwards of 47 feet, succeed each other alternately in regular unbroken order; the next bed, however (28th in the sections), instead of being a mass of vegetable matter, as was due, is a second bed of clay, and, in the first section, of unequalled thickness; this is followed by a thick bed of sand, the first which presented itself. Clearly some change must have occurred. Had the accumulated deposit so far shallowed the waters of the ancient lake? Had it conveyed its western margin so far eastward, that sand was to be henceforward deposited in the area hitherto appropriated to clay, instead of further west as heretofore? If so, it might have been expected that the change would have been less sudden. No sand whatever had previously occurred. Moreover, on this hypothesis it is reasonable to suppose that sand would have been largely deposited in future, instead of which the old order (of clay and lignite alternately) is continued for eighteen additional beds, increasing the depth of the deposit by nearly 40 feet; indeed, omitting the two arenaceous beds (9th and 11th) which occur only in the first section, we have no more sand until the uppermost bed of lignite in the sections had been formed. In no instance does the lignite rest on or support sand, but always clay.

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* See Plate II.

Almost all the clay-beds contain fragments of lignite, which are commonly, at least approximately, parallel to the plane of stratification. One or two exceptions to this were met with, the most marked being that of the 35th bed, where they occur at all angles to that plane.

Though when first dug the clay is not generally characterized by lamination, exposure to the atmosphere, in most cases, developes this quality.

Fossils were found in only fifteen of the beds, namely, one of clay and four of lignite in the second series, and one of the former and nine of the latter in the third or lowest. It is only necessary to particularize the 7th, 25th, 26th, and 46th beds.

The 7th is chiefly remarkable as being a mat composed of fragments of the coniferous tree *Sequoia Couttsiæ*, HEER, and of the fern *Pecopteris lignitum*, GIEB.

The 25th is that in which the so-called "flabelliform leaves" chiefly occur; a few were also met with in the 17th bed. Professor HEER has identified them as the rhizomes of ferns. Some of them were fully 5 feet in length, but too brittle to be got out entire. In most cases the large specimens have a curved outline. The lowest three inches of the bed is commonly a mat of fragmentary fronds of the ferns *Pecopteris lignitum* and *Lastrea stiriaca*, UNG.,—the first being the most prevalent. Above this lie the rhizomes, in a continuous band about 6 inches thick. Though these bands generally preserve a well-marked separation, they sometimes inosculate, but never so as to show whether the fossils were parts of the same plant. The uppermost portion of the bed consists of slabs of "board coal" of great length, and of a width indicating the existence of trees (probably *Sequoia Couttsiæ*) fully 6 feet in diameter. Bodies occur in this bed having the appearance of roots, with rootlets passing into the clay below. Mr. KEEPING reported one such "root" having a part of the stem of a tree still attached to it, the latter being almost perpendicular to the plane of stratification. The lignite in this stratum not unfrequently presents a fretted aspect, as if from some kind of corrosive action; in these cases it is crossed by cracks or fissures of variable width, having rugged walls, and filled with yellow ochre.

The 26th is the most important bed in the series, being rich in both the number and the variety of its fossils. The lowest six inches contain a large number of dicotyledonous leaves, most of them crushed and valueless; occasionally, however, nests or patches of such leaves occur in a better condition. A few twigs of *Sequoia Couttsiæ* are also found in this lowest band; whilst quite at its base are numerous branches of the same plant, measuring in some instances 3 feet in length and from a quarter of an inch to 4 inches wide. In most cases the large specimens are extremely brittle.

The next fifteen inches constitute a middle band, containing some *Sequoia*-débris and a considerable number of crushed leaves, the latter suggesting the idea that they had been deposited on a very uneven surface. A thin layer of "charred" lignite, several feet in length, was found in the middle of this band.

The remaining part of the bed (the uppermost four inches) abounds in seeds of various kinds; but it is chiefly marked by remains of *Sequoia*. It is not too much to say that every museum in the world might readily be supplied with thousands of specimens of this plant from this band. It is represented by branches, twigs covered with leaves, fruits (sometimes, but more frequently not, attached to the twigs), and seeds. A few dicotyledonous leaves occur here also.

Though most abundant in this bed, the *Sequoia* occurs also in the 7th, 40th, and 63rd —that is, the highest and lowest beds which have yielded fossils. The Bovey deposit evidently represents but one flora.

The 46th bed yielded a very large number of small seed-vessels (*Carpolithes nitens*, HEER), which, like those described by Dr. HOOKER, in 1855, under the name of *Folliculites minutulus*, but which Professor HEER has identified as *Carpolithes Websteri*, BR., are "thickly strewed over the surfaces of the laminæ of lignite, and slightly imbedded in them as if the latter had been soft when the deposit was formed. They lie in all directions, but always on their flat surfaces"*. They are by no means confined to this bed, though more abundant in it than elsewhere.

Nothing resembling the cone of *Pinus sylvestris*, described by Dr. HOOKER, was found during our exploration. But for its complete "carbonization and bituminization," I should believe that it belonged to a neighbouring bog, mentioned by several writers, "from which have been taken, several feet below the surface, many trees of the fir kind; several 18 inches in diameter, together with pine-nuts, but no coal"†.

In some of the lower beds, close-fitting joints not unfrequently occur in the lignite, the surfaces of which (rarely planes) have a high polish: the workmen call such pieces "glassy;" and the term aptly expresses the character. They also call them "slides," believing them to be "Slickensides." There do not appear to be any "faults" in the beds at the pit.

It has already been stated that the lignite often has a "charred" appearance; and indeed it is somewhat difficult to believe that it has not ignited spontaneously; nor are we without facts which give some support to this opinion. It is well ascertained that the combustion so prevalent in the heaps of refuse is spontaneous, and the lignite beds are sometimes found to be on fire in the tunnels or "ends." Mr. DIVETT, writing me on this question, says, "Some ten or twelve years since, I found a fire raging in an 'end' at the western extremity of the pit, which had been abandoned for some months. I enclosed the main western 'end' with a dam of timber and clay, in the hope of extinguishing the fire, but only succeeded in checking it. This part of the pit was buried by a run of clay from the north for many years, and was excavated again about twelve months since, when the fire was still burning. It is now again buried by 'run' sand. I have never doubted that this ignition was spontaneous." Mr. HATCHETT, however, who gave much attention to the chemistry of the lignite, was of opinion that there was no evidence of true combustion‡.

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* Quart. Journ. Geol. Soc. vol. xi. p. 566.

† Mr. SCAMMELL, in PARKINSON'S 'Organic Remains,' vol. i. Letter 12, p. 129.

‡ Trans. Linn. Soc. vol. iv. p. 141, &c.; also Philosophical Transactions for 1804, Part I. p. 396, &c.

Newly exposed surfaces of the laminæ of the lignite are sometimes more or less covered with stellate crystals of selenite. Their beauty is very striking, and is enhanced by contrast with the dull dark surface on which they lie; unfortunately it is by no means durable; the stars first lose their brilliancy, after which many of them disappear altogether.

Fragmentary pieces of lignite occasionally occur in the "coal-beds" as well as in the clay; some of them are perfectly flat slabs, of various sizes, having sides and ends as true and angular as if they had been something more than rough-hewn in a carpenter's shop. Others have an appearance resembling stranded drift-wood; I found a well-marked piece of this character in the 72nd bed.

The flattened form which the "board coal" commonly assumes is by no means confined to the lowest beds; it is as characteristic of the 5th, or uppermost, and of that portion of it which most nearly reaches the surface, as of any bed in the pit sections. As pressure must be regarded as essential to this flatness, though probably not its sole cause*, it seems impossible to avoid the conclusion that much of the superior portion of the deposit has been removed by denudation. It must not be supposed, however, that all samples of "board coal," taken from any one bed, are equally flattened. Examples occasionally present themselves, of portions of stems and branches, in which the original curvature of outline is not entirely obliterated—the transverse section distinctly showing the rings of annual growth converted into ellipses of great excentricity. Good instances of this have been met with in the lowest beds.

The stones so abundant in the "Head," or uppermost division of the pit sections, are sufficient to show that it was formed under conditions dissimilar to those which produced the two lower series. Moreover, it lies unconformably on them. Nowhere in the excavation do the lignite and interstratified beds reach the surface; they are cut off at distances varying from 3 to 7 feet below it, as is shown in Plate II.

It has already been stated that the stones of the "Head" are generally angular or subangular; occasionally, however, some occur that are much rounded. They vary in size, from blocks upwards of a foot in mean diameter to pieces not larger than hazelnuts. On Bovey Heathfield they are fragments of granite, metamorphic rock, carbonaceous grit, and trap, with a very few of flint and chert. The two last increase in number eastward—that is, with increased proximity to the Cretaceous district,—and in some localities are even more abundant than other detritus.

In no instance have I found or heard of limestone-fragments on the Bovey Heathfield. A transporting current from the north or north-north-east seems to be required to meet the facts of the case. Were it not for the samples of flint and chert, a movement from the west or north-west, or even south-west, might have supplied the materials. No agent progressing from any part of the compass between the north-east and south-west, through south, could have furnished the granite-blocks or failed to transport large quantities of limestone-débris. On the whole I incline to a transportation from a northerly direction, rather east than west of true north,—that is, a current, or other agent, moving in a line nearly at right angles to that in which the sands and clays of the true Bovey beds travelled from Dartmoor—a fact, concurring with those previously mentioned, in favour of a great chronological interval between the "Head" and the deposit it covers.

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* See Hatchett in Philosophical Transactions for 1804, Part I. p 397.

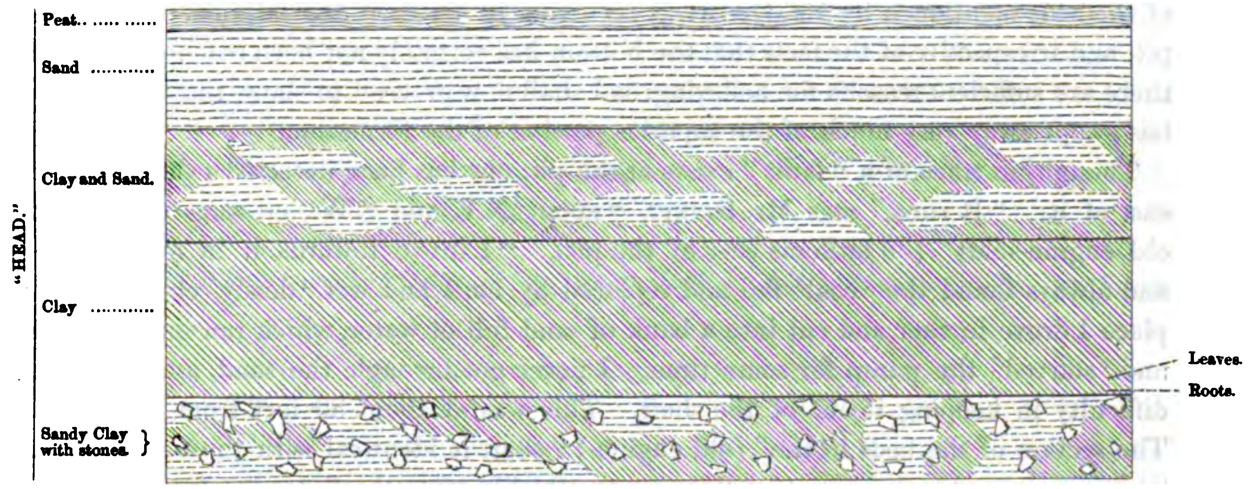
Nor are we without *organic* evidence of the lapse of time between these formations. During our exploration at Bovey, I had an opportunity of examining and measuring a section made by workmen digging clay, in the "Head," on the Heathfield, about a quarter of a mile east of the pit. The results were as below.

Section 4, *of the* "*Head*" *at Bovey Heathfield.*

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
1*		6		6	Peat.
2	2	6	3	0	Sand.—Fine, white, quartzose.
3	3	0	6	0	Clay and Sand.—In separate masses, but not distinctly stratified. The clay more abundant than the sand.
4	4	0	10	0	Clay.—Very white.
5 unknown.					Sandy Clay.—With angular and subangular stones.

Some time afterward we found a considerable number of dicotyledonous leaves, lying in the white clay, nine feet below the surface of the plain, and immediately below them lay some large roots. Professor Heer assigns the leaves to a period much more modern than that represented by the lignite-beds, yet to one characterized by a "colder climate than Devonshire has at the present day," thus confirming Mr. Godwin-Austen's opinion, that the "Head" belongs to the "period prior to the most recent change of climate"†. The position of the leaves is indicated in fig. 1, which is drawn on the scale of 0·2 inch to 1 foot.

Fig. 1.



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* The beds in this section and in those which succeed, do not represent those which bear the same numerals in the pit sections.

† Geol. Trans. 2nd Series, vol. vi. p. 437, &c.

Though in the pit section No. 1 the 5th is the highest, and the 72nd the lowest bed of lignite, it would manifestly be unsafe to conclude that no higher or lower beds exist; and indeed Mr. Divett, in a letter on this point, says, "In a shaft sunk 135 fathoms south of the pit" (*i. e.* in the direction of the *dip* of the beds) "I had, in 99 feet sinking, some good beds of coal. When we ceased to sink we had, I believe, some six or seven fathoms between us and the top of the uppermost bed of lignite in your sections." This estimate, as to the depth at which the "5th" bed would have been cut, is fully borne out by the *dip* of the beds and the distance of the shaft, if we assume that no "fault" exists in the interval and the *dip* remains constant. On both these points we have direct confirmatory evidence for the distance of sixty-three fathoms south of the pit, as subterranean workings have been carried so far, "by driving down the dip," and show that the beds exist in unbroken continuity and uniform inclination; that is, the beds have been followed to a depth of 80 feet below the bottom of the "Coal-pit."

Though the workmen have named the 72nd the "last bed," it is no more than an expression of the fact that it is the last or lowest they work. That there are still lower beds is certain, since Mr. Divett says, "I sank a shaft about 13 feet" (below the bottom of the pit) "and cut two tolerable beds of coal." The workmen speak of still earlier and deeper borings, and state that thin layers, or "shells," of lignite were found separated by thick beds of "muddy clay." Omitting these traditions, however, we are now in possession of the following figures. The 72nd, or "last" bed is, at the western end of the pit, about 100 feet vertically below the surface of the plain; or, measured at right angles to the plane of stratification, we have, to the base of this bed, a thickness for the deposit of 125 feet*; the pit beds have been followed 80 feet lower, and lignite has been cut 13 feet below the so-called "last" bed; giving an aggregate of 218 feet, inclusive of the "Head," or upwards of 35 fathoms for the true Bovey deposit; exclusive of the beds mentioned by Mr. Divett as occurring in his shaft 135 fathoms south of the pit, and irrespective of the facts that the bottom has certainly not been reached, and that there are sufficient reasons for believing, as I shall now proceed to show, that denudation has swept away very much of the superior portion of the formation.

Though no trace of a "fault" exists at the pit, one has been detected a short distance east of it. "It runs," says Mr. Divett, "about N.E. and S.W., crossing close to the old engine-shaft" (56 fathoms east of the pit). "I drove towards it in many places, and always found the 'coal' fail and replaced by hard and wet 'deady' clay. At one place I drove further and cut into a bank of sand full of water, which ran into the shaft and 'starved' the pump for some time. I never got through the sand, and had great difficulty in keeping it out of the shaft. This was at about 80 feet from the surface. The section of the beds in the" (old engine-) "shaft is identical with those in the pit." The accompanying diagram (fig. 2) may serve to illustrate the foregoing facts. Let the surface of the paper represent a horizontal plane, on the level of the bottom of the coal-pit, at its eastern end, about 80 feet below the surface. Let A B be a portion of a tunnel, or "working," on that level, on the eastern side of the pit, running, about N.E. and S.W., near and parallel to the plane of the "fault." C the old engine-shaft, 56 fathoms east of the pit. D and F various places at which Mr. Divett drove horizontally from the eastern side of the tunnel. In doing so he "always found the coal fail and replaced by hard and wet 'deady' clay;" at F he "drove further, and cut into a bank of sand;" in fact he seems here to have cut *through*, but elsewhere *into*, a dyke composed of heterogeneous materials; beyond which he encountered a bed of "sand full of water;" doubtless the 13th bed in the following section (No. 5), which, it will be seen, exists at the required depth ("80 feet below the surface"*).

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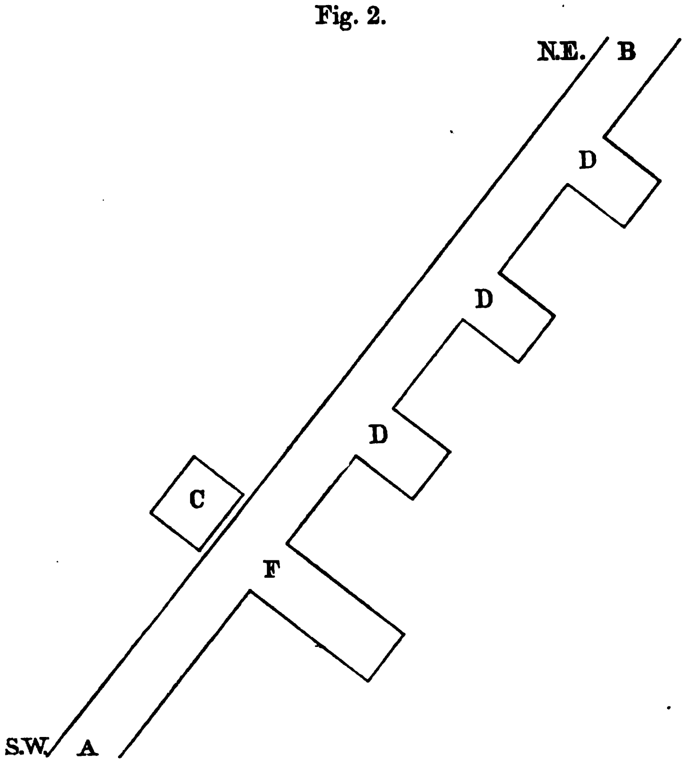
* See Section 1, page 6.

Fig. 2.



Mr. Divett proceeds to say, "About 70 fathoms east of the shaft, I bored, in 1855, 99 feet, when I obtained the following section."

Section 5. 70 *fathoms east of the Fault on Bovey Heathfield* (furnished by J. Divett, Esq.).

Beds.	Thickness. ft.	Thickness. in.	Totals. ft.	Totals. in.	
1	13	0	13	0	Gravels and Clays.—("Head.")
2	11	0	24	0	Sand.
3	4	0	28	0	Black Clay.
4	2	0	30	0	"Deady Ground."
5	6	0	36	0	Sand.
6	3	6	39	6	Clay.
7	4	6	44	0	Sand.

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* See Plate III.

Beds.	Thickness. ft.	in.	Totals. ft.	in.	
8	8	0	52	0	CLAY.
9	13	0	65	0	SAND.
10	7	0	72	0	CLAY.
11		2	72	2	COAL.
12		10	73	0	CLAY.
13	11	0	84	0	BLUE SAND.
14	3	0	87	0	WHITE CLAY.
15		6	87	6	COALY CLAY.
16	1	6	89	0	SAND.
17	10	0	99	0	COALY CLAY*.

I learn from the workmen, that the 13th bed of sand was "full of water," like that encountered by Mr. DIVETT, and that it gave them great trouble by running into the boring whenever the instrument was withdrawn.

The foregoing section is situated, from the first three, as nearly as possible in the direction of the *Strike* of the formation. It has a depth about the same as the pit at its western end, where a vertical line cuts 27 "coal" beds having an aggregate thickness of nearly 36 feet; instead of the solitary layer of 2 inches only in the Table just given. Those beds are known to exist, in unbroken continuity, along the entire length of the western tunnel and the coal-pit, and onwards to the old engine-shaft, a distance of nearly half a mile; here they suddenly cease and their place is supplied by a series of beds having the characteristics of the uppermost portion of the second division of the pit sections. The contrast of the two will be seen in Plate III.

There can be no doubt that these facts are evidence of a great fault; that the beds on the east of it are an upper portion of the Bovey deposit, preserved, through the intervention of a vertical displacement of at least 100 feet, from the denuding action which swept it away on the west, after it had, by its pressure, assisted to flatten the timber in the uppermost stratum of lignite at present existing there; and that this denudation occurred before the deposition of the "Head," since this is found covering the deposit alike, without considerable variation in its thickness, on each side of the "*fault.*" It will be understood that it is by no means intended to intimate that this is the only fault in the Bovey formation; the occurrence of beds of lignite, near the surface, in various parts of the Heathfield, renders it probable that there is, at least, another. Nor is it meant to express the opinion that the "Head" itself may not have lost much by denudation; so far as they are at present understood, certain facts seem to imply that it may have suffered much in this way.

Though the neighbourhood of Bovey was necessarily regarded as the head-quarters of the formation, it was felt to be desirable that some attention should be given to certain other localities, in various parts of the basin, where clay-pits exist.

The clay-works at Aller, in the parish of Abbotskerswill, adjacent to the road from Torquay to Newton, and about two miles from the latter, have been abandoned some years. Lignite seems to have been found there in considerable quantity. Samples of it, shown me by one of the old workmen, displayed the common woody character so usual at Bovey, but no traces of leaves or other fossils. There appear to have been seven distinct beds of lignite alternating with as many of clay, the latter from 2 to 4 feet thick. Of the former, the lowest were the most compact, and were from 3 to 3½ feet in thickness, whilst the upper ones were thinner and contained a considerable admixture of clay. The whole were covered, unconformably, with gravel to the depth of 20 feet.

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* This section is exhibited in Plate III. (eastern section).

Clay is largely dug at the Decoy, in the parish of Woolborough, about half a mile south-west of the Newton railway station. In an artificial dyke, or water-course, two beds of lignite, separated by a layer of black clay, are well exposed. The entire cutting is about 10 feet deep, the uppermost three feet being coarse gravel surmounted by a thin layer of peat. The larger stones in the gravel are commonly flint and chert, the smaller are partly, perhaps mainly, Dartmoor débris. Beneath this are the Bovey beds dipping towards north 80° East, at an angle of 60° at the top and 50° at the bottom, the beds having somewhat curved surfaces. The western, or lowest bed of lignite is 9 feet thick, the eastern 6 feet, and the intermediate clay about 5 feet; the whole lies between clay similar to the interstratified bed. Further west, or still lower, is a valuable bed of "pipeclay," whilst on the eastern side is a good bed of the black, or "potter's clay."

Though we spent some days seeking fossils here, the only things found were two small bodies, probably seeds, and one undoubted twig, with leaves, of *Sequoia Couttsiæ*. The latter, though a very inferior specimen of this fossil, is valuable as a link of identification between the lignite of the Decoy and that of Bovey Tracey.

Considerable quantities of both white and black clay are also excavated in the parish of Kingsteignton, about two miles north of Newton, very near the eastern margin of the deposit. I measured the following section in one of Mr. Whiteway's "black pits."

Section 6, *of the Bovey Deposit near Kingsteignton.*

Beds.	Thickness.		Totals.		
	ft.	in.	ft.	in.	
1	15	0	15	0	"Head," consisting of angular and subangular flint, chert, and Dartmoor débris.
2	2	8	17	8	Clay.—Black. "Not Saving."
3	1	6	19	2	Clay with Lignite.
4	4	0	23	2	Clay and Sand.—Contains root-like portions of lignite.
5	4	0	27	2	"Shovel" Sand.—Thickness variable.
6	8	0	35	2	Clay.—Black. "Saving."
7	3	0	38	2	Clay.—Black. "Short." Thickness variable.
8	12	0	50	2	"Bottom" Clay.—"Saving."
9	Thickness unknown.				Sand.

The workmen denominate the clay "Saving" or "Not Saving," according as it has or has not a commercial value. Sand so loose as to be capable of removal by the use of a spade or shovel only, is termed "Shovel" Sand. Clay but slightly plastic is spoken of as "Short;" and "Bottom" Clay expresses the fact that no argillaceous deposit, having commercial value, is found below it.

None of the workmen appear to have found or heard of anything in the shape of gravel at the base of the clay series[*]. Sometimes, but not frequently, small, well-rounded, smooth quartz pebbles, about the size of a common pea, occur in the best clay; and mundic is said to be not uncommon.

The *dip* of the beds at this pit is about 8° towards N. 50° W. It is said to vary somewhat both in amount and direction, but is generally less northerly than the above. As at the Decoy, the white clay underlies the black.

Though lignite occurs here, it is less abundant than in either of the other areas which have been mentioned; from the report of the workmen, however, it is occasionally found, especially in the pits more removed from the margin of the deposit, in larger bodies than in the section just given. Our search for fossils was altogether without success.

At the suggestion of Dr. FALCONER, and also of Sir CHARLES LYELL, it was decided to submit the collection of fossils, which we had made at Bovey, to Professor HEER of Zürich, in the hope that he would succeed in extracting from them their chronological secret. Accordingly, the necessary arrangements having been made by Sir CHARLES LYELL, I sent him all the drawings of the fossils, prepared by Mr. FITCH of Kew, together with a large and, so far as I could judge, characteristic series of the specimens themselves, and in a short time had the gratification of learning that he had determined forty-five species of plants, of which forty-one were from the lignite series and four from the "Head," the former being decidedly of the lower miocene age, whilst the latter were much more modern.

Though, when he subsequently reached this country, Professor HEER failed to detect, in the remainder (the bulk) of the collection, any species which he had not previously seen, he was more fortunate at Bovey; where, in the few days he was able to devote to the deposit, he added nine new species of fossil plants to the list, and, by the discovery of an insect, *Buprestes Falconeri*, detected the first evidence of animal life which has been exhumed there.

From the decision just mentioned, it appears that the Bovey lignites are the contemporaries of the "Hempstead Beds" in the Isle of Wight, first discovered by the late lamented Professor EDWARD FORBES in 1852, and described by him in the following year[†]. Though their discoverer always regarded them as Upper Eocene, they have recently been grouped amongst the Lower Miocene[‡]; this, however, is a question of classification; wherever they find a resting-place, the Bovey beds must accompany them, since they are on, or very near, the same horizon.

The ancient miocene lake of Devonshire which we have been considering, must have been of great depth; the lowest figures mentioned in an earlier page give at least 35 fathoms, whilst, if to this we add those obtained from the "fault," it amounts to fully 50 fathoms; indeed the clay-workers assert that their borings sometimes amount to quite this depth. The present surface of the plain, however, is, at the pit, no more than 15 fathoms above the ordinary level of spring-tide high water, so that the bottom of the lake would be at least 35 fathoms below the level of the sea. Yet, says Professor HEER, and apparently on unimpeachable data, "it was a fresh-water lake." The country, then, must have stood at a much higher level than at present, or a barrier existed between the lake and the sea. Unless, however, there have been very local changes of level, the former hypothesis is disposed of by the fact that the Hempstead beds are of fluvio-marine origin, and must therefore have been formed at a level much below that which they at present occupy. A barrier, then, must have existed somewhere in the present tidal estuary of the Teign, over which the surplus waters of the lake passed to the ocean, or which, by its superior height, caused the waters to find an outlet in Torbay. Judging from the physical features of the two valleys leading from Newton to the English Channel, one by Teignmouth and the other by Torquay, the former is far more likely than the latter to have been the course followed.

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[*] See Mr. GODWIN-AUSTEN, in Trans. Geol. Soc. 2nd Series, vol. vi. part 2, p. 448; also Sir H. DE LA BECHE, in his 'Report,' p. 257.

[†] Quart. Journ. Geol. Soc. vol. ix. p. 259, &c.

[‡] Sir C. LYELL'S 'Supplement' to the fifth edition of his 'Manual,' p. 6, &c., 1857.

The period represented by the Bovey beds must have been of considerable duration. So far as the strata themselves show, it was, in the district under consideration, one of great tranquillity. A long series of beds, alternately vegetable matter and fine clay, succeed each other in scarcely interrupted order; the three intruded arenaceous layers probably mark nothing more than a somewhat increased velocity in the current, or river, which conveyed the detritus of the granite hills of Dartmoor into the area of deposition, but which, instead of being permanent, was as short-lived as it was unusual.

The late investigations at Bovey, then, have been so far successful that they have settled the vexed question of the age of the deposits occurring there,—added forty-nine species to the fossil flora of this country, of which twenty-six are new to science,—recognized the first traces of animal life which the deposit has yielded,—detected another British fragment of the miocene page of the earth's history, which, until 1857, was supposed to be totally unrepresented in England,—taken us back to a remote period when the slopes of Devonshire were clothed with a luxuriant subtropical vegetation,—and separated, by a wide chronological hiatus, the lignite and associated beds from the gravels overlying them—a hiatus evidenced by the dissimilarity and unconformability of the two series, by a change in the direction by which detrital matter reached the Bovey area, by great vertical displacements of the lower series, followed by denudation of the consequent surface-inequalities prior to the deposition of the upper, and by the exchange of an extinct flora, requiring a high temperature, for an existing one, which is now confined to arctic and alpine regions.

Remote, however, as was the earliest of the two periods thus represented, the great leading geographical features of the district were pretty much as at present. The Teign and Bovey rivers were then in existence, but instead of the latter being tributary to the former, their mouths were three miles apart, and both fell into the same deep, sluggish, fresh-water lake; occupying the site of the present Bovey plain, and guarded by Dartmoor and the other hills which still constitute the prominent characteristics of the district.

Explanation of the Plates.

PLATE I.

Is copied, with very slight alterations, from the twenty-sixth sheet of the Map published by the Geological Survey of Great Britain; and, like the original, is on the scale of 1 inch to a mile.

PLATE II.

Is a section of the Bovey formation, in the plane of the *Dip* of the beds. It is drawn, from the measurements obtained in the "first section," given in the text (see p. 4, &c.), on the scale of $\frac{1}{168}$, or 1 inch to 14 feet. The *Dip* amounts to 12½°, and is in the direction S. 35° W. magnetic. The beds in which fossils were found are those the numbers of which are placed opposite them in the margins.

PLATE III.

Contains two sections of the formation, in the plane of the *Strike* of the beds, and is intended to show the nature of the evidence for the existence of the "*Fault.*" The scale of thickness, in each, is $\frac{1}{120}$, or 1 inch to 10 feet; and the total depth below the surface is 99 feet.

The symbols have the same meaning in both.

a is the "old engine-shaft."

b. The eastern end of the "Coal-pit;" 56 fathoms west of *a*.

c. Mr. Divett's "boring;" 70 fathoms east of *a*.

d, 80 feet below the surface, is a horizontal excavation very near the engine-shaft, and opening eastward out of a "working" which runs parallel and adjacent to the "Fault" (see fig. 2).

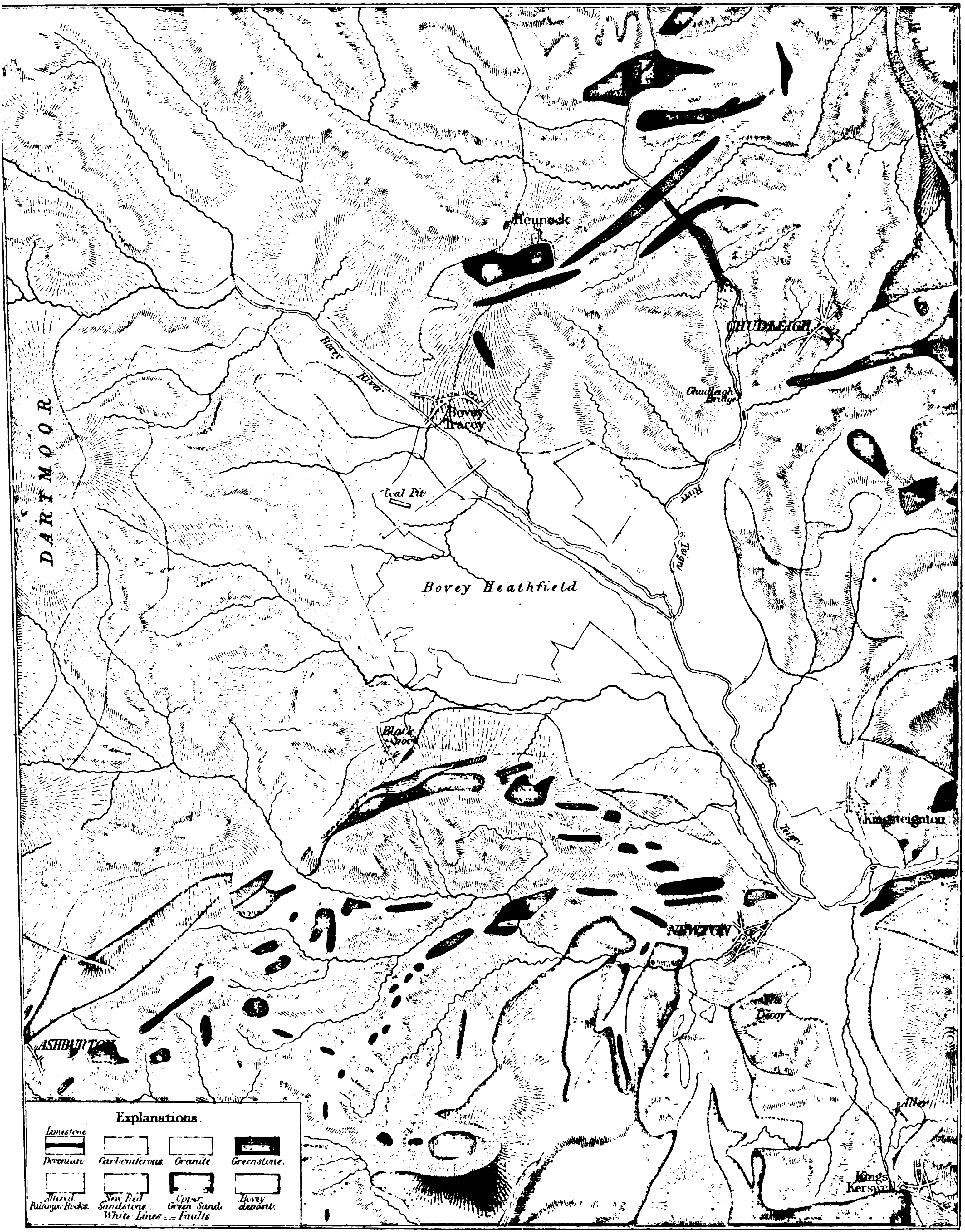
e f is the hypothetical *plane* of the "Fault."

With the omission of a few unimportant local differences, the western section represents the ascertained succession and thickness of the beds from *a* to nearly half a mile westward. They are probably continued much further in this direction, but are known to terminate eastward abruptly at the "Fault," *e f*, immediately east of *a*. The lowest bed shown is the 62nd in the "pit" sections.

The eastern section is drawn from the data obtained in Mr. Divett's "boring" at *c*, (p. 15,) and shows all the beds cut there. These are assumed to extend, in the same order, westward to *e f*; and though no excavations have been made at the surface in the intermediate space, the assumption is by no means gratuitous, since a bed of sand, having the same characters and at the same depth below the surface, has been met with both in the "boring" *c* and the excavation *d*.

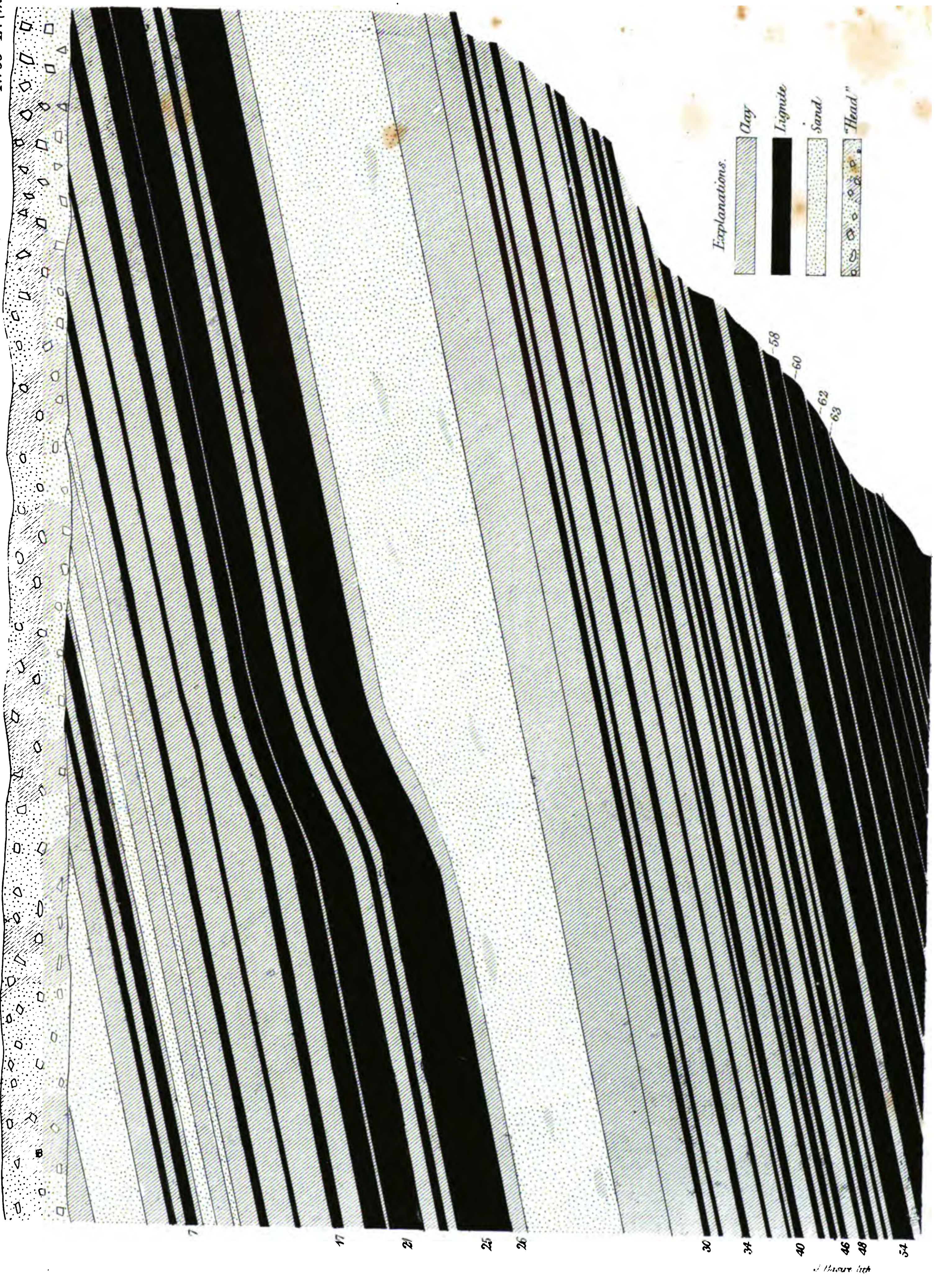
Though the existence and situation of the "Fault" has been well ascertained, the angle which its plane (?), *e f*, makes with the horizon is not so well known. In the absence of complete evidence on this point, it has been thought best to draw it at right angles, more especially as the evidence, so far as it goes, is to that effect.

PLATE I.



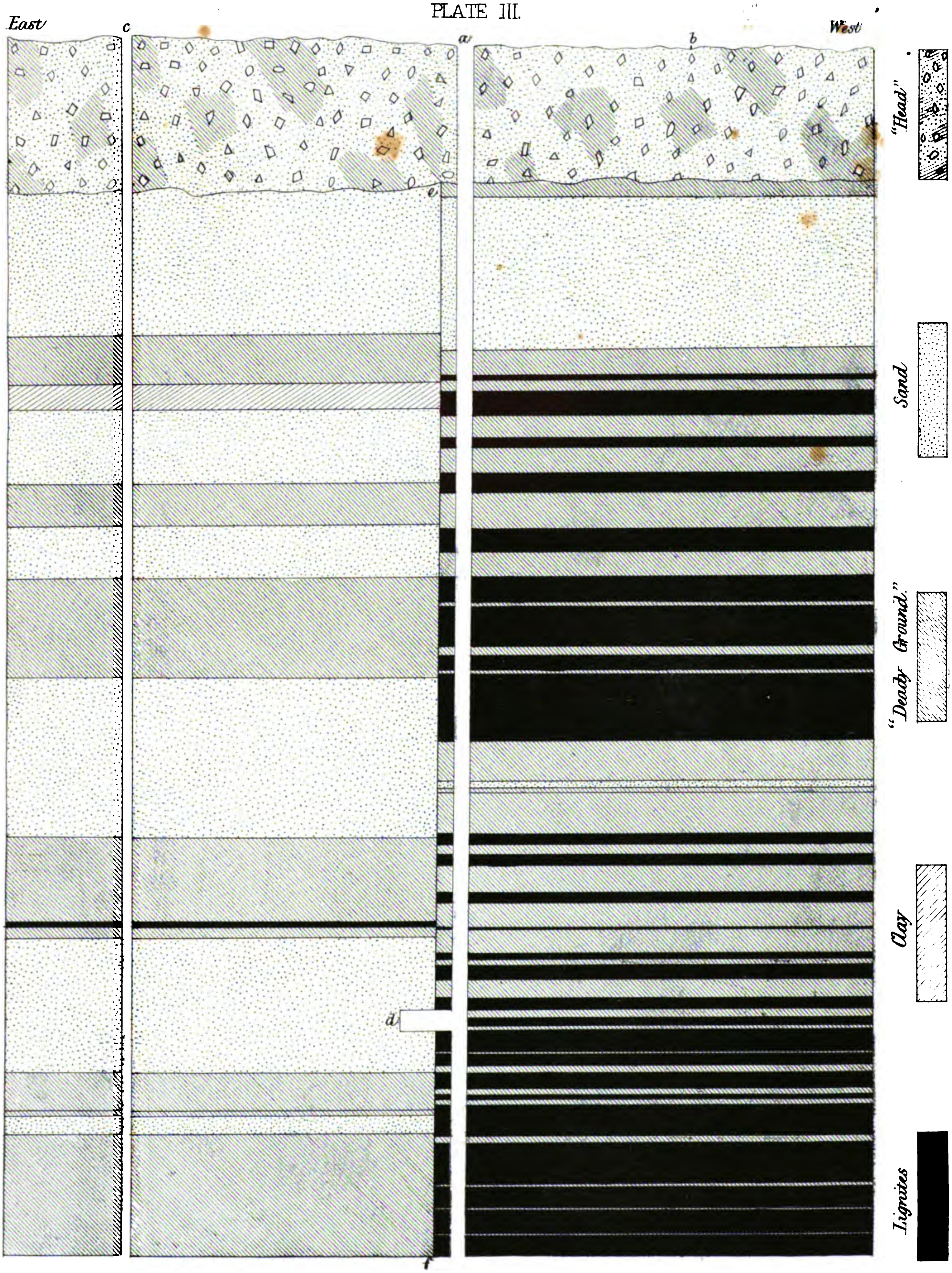
W. West, imp. Hatton Garden.

PLATE II.



J. Basire lith.

PLATE III.



J Basire lith.

On the Fossil Flora of Bovey Tracey. By Dr. OSWALD HEER, *Professor of Botany, and Director of the Botanical Gardens in Zürich. Communicated by Sir* C. LYELL.

Received November 16,—Read November 21, 1861.

IN the middle of the extensive plain which is bounded by the slopes of Bovey, are the potteries of Mr. DIVETT, for which fuel was formerly supplied by the lignite excavated there. In order to obtain this lignite a deep cutting has been made, and a sort of small ravine formed, on the sides of which the stratification is exposed. The surface-covering consists of a light-coloured quartzose sand, which contains here and there considerable beds of white clay. By the plants contained in it this formation is assigned to the Diluvium. Immediately under it come the beds of clay and lignite described by Mr. PENGELLY in the foregoing paper, which are all referable to *one* formation, as several kinds of plants are common to the different beds. The *Sequoia Couttsiæ* and *Pecopteris lignitum* occur in the 7th, 17th, 26th, 40th, and 63rd beds. *Carpolithes Websteri* is certainly found in the greatest abundance in the 54th bed, yet occurs also, though very rarely, in the 25th bed; *Cinnamomum Scheuchzeri* and *C. lanceolatum* in the 17th and 26th. The formation to which these strata belong is far older than that of the overlying white clay; the plants found in the former prove them to belong unquestionably to the *Miocene* period, and accordingly we must treat of them separately.

A. *The Miocene Formation of Bovey.*

Of the fifty species of plants which have hitherto been discovered in the lignite beds of Bovey, twenty-one occur also on the Continent in the Miocene formation. The lignite of Bovey Tracey is therefore undoubtedly Miocene; and it is worthy of special remark, that the species of *Cinnamomum* which are so characteristic of the Miocene and so generally distributed through it make their appearance in Bovey precisely as in the lignites and molasse of the rest of Europe. Equally characteristic are the *Lastræa Stiriaca*, the fern of most universal distribution over Miocene Europe, the ornate striated seeds of the *Gardenia Wetzleri*, and the fruits of *Carpolithes Websteri*, which are known to us from Germany, Switzerland, and Italy.

The following conspectus exhibits the proportions in which some of the species found at Bovey have been observed in other districts:—

	Tongrian.	Aquitanian.	Mayencian.	Helvetian.	Œningian.
Lastræa Stiriaca, *Ung.*, sp.	....	Monod; Hohe Rhonen; Paudèze; Wetterau; Ménat; Cadibona.	Radoboj; Eriz; Riethhäusli and Ruppen, St. Gallen.	......	Albis, very rare; Parschlug; Sarzanello.
Pecopteris lignitum, *Gieb.*	Weissenfels	Thôrens, Savoy; Manosque, Provence; Wetterau.	....	......	....
Sequoia Couttsiæ, *m.* ...	Hempstead, Isle of Wight.	Armissan, near Narbonne.	....	......	....
Palmacites Dæmonorops, *Ung.*, sp.	....	Salzhausen	....	......	....
Quercus Lyelli, *m.*	....	Altsattel in Bohemia.	....	......	....
Laurus primigenia, *Ung.*	Sotzka; Bornstedt; Weissenfels; Salzedo; Novale.	Rivaz; H. Rhonen; Spebach; Cadibona.	Eriz; St. Gallen	......	....
Cinnamomum Rossmässleri, *Hr.*	Haering; Mt. Promina; Salzedo.	Rothenthurm; Altsattel; Reut; Westerwald; Sagor.	Lausanne; Solitude near St. Gallen; Radoboj; Bilin.	Turin	Albis; Wangen; Parschlug; Senegaglia.
—— Scheuchzeri, *Hr.* ...	Sotzka	Common everywhere.	Common everywhere.	Common ...	Common everywhere.
—— lanceolatum, *Ung.*, sp.	Common	Common everywhere.	Common everywhere.	Rare	Very rare; Albis; Ischel.
Daphnogene Ungeri, *Hr.*	Sotzka	Lignite of Bonn; Westerwald; Manosque.	Develier	......	Irchel; Schrotzburg; Wangen.
Dryandroides hakeæfolia, *Ung.*	Sotzka; Mt. Promina; Haering; Salzedo.	Monod; Rivaz; Rochette; H. Rhonen; Rufi; Baltenschweil; Sagor; Peissenberg; Foveagedo.	....	......	....
—— lævigata, *Hr.*	Weissenfels	Monod; Rivaz; H. Rhonen; Peissenberg; Cadibona; Manosque.	....	......	....
Nyssa europæa, *Ung.* ...	....	Salzhausen; Nidda.	....	......	....
Vaccinium acheronticum, *Ung.*	Sotzka; Sieblos; Haering; Salzedo; Chiavon; Taurus.	Monod; H. Rhonen; Sagor; Lignite of Bonn.	Develier; Schangnau; Radoboj; Rhön.	Petit Mont, Lausanne; St. Gallen.	Œningen; Schrotzburg; Parschlug; Senegaglia.
Andromeda vacciniifolia, *Ung.*	Sotzka; Taurus ...	Monod.	Mönzlen	......	....
—— reticulata, *Ett.*	Hempstead; Haering; Sieblos.	....	....	......	....
Echitonium cuspidatum, *Hr.*	....	Manosque	....	......	Locle.
Gardenia Wetzleri, *Hr.* ..	....	Salzhausen; Samland.	Rhön; Günzburg; Buckers.	......	....
Nymphæa Doris, *m.*	Hempstead	....	....	......	....
Eugenia Hæringiana, *Ung.*	Haering; Sieblos; Reut.	Ralligen	Lausanne; Calvaire; St. Gallen; Rhön.	Petit Mont, Lausanne; Turin.	....
Celastrus pseudo-ilex, *Ett.*	Haering	....	Rhön	......	Locle; Œningen; Hohen Krähen; Bischofsheim.
Carpolithes Websteri, *Br.*	Hempstead	Rochette; Conversion; Westerwald; Salzhausen; Laubach; Cadibona.	Rhön; Eisgraben; Zeche Einigkeit; Kaltennordheim.	......	....

A glance at this Table will at once satisfy us that the lignites of Bovey must be referred to the Lower Miocene division, and to the Aquitanian stage of it. It is true that nine of the species are found also in the Upper Miocene of other places, but these are all species which occur also in the lower stages, and which had a very extensive distribution both in time and space. Twelve species have been observed in the Mayencian and sixteen in the Tongrian stage; but nineteen have been identified in the Aquitanian stage in various localities. Certain species (*Palmacites Dæmonorops*, *Quercus Lyelli*, and *Nyssa europæa*) are not yet known in other districts as belonging to any but the Aquitanian stage; two (*Andromeda reticulata* and *Nymphæa Doris*) are known only in the Tongrian; others (*Pecopteris lignitum*, *Sequoia Couttsiæ*, *Dryandroides hakeæfolia*, and *D. lævigata*) only in the Tongrian and Aquitanian.

In this conspectus we have omitted the doubtful species (*Phragmites Œningensis*, *Dryandroides Banksiæfolia*, *Eucalyptus oceanica*, and *Pterocarya denticulata*). Should these be established by specimens in a better state of preservation, no disturbance would ensue to the above result, inasmuch as the *Phragmites* reaches back to the Lower Miocene, the *Eucalyptus* and *Dryandroides* belong to the Tongrian and the Aquitanian, the *Pterocarya* to the Aquitanian.

If we compare the Bovey flora with the several Continental floras, we shall find a great coincidence between it and that of Salzhausen in the Wetterau. A couple of species, viz. *Palmacites Dæmonorops* and *Nyssa europæa*, were previously known only from that district, while others, as *Pecopteris lignitum*, have been rarely found in other localities. With the Aquitanian stage of the Swiss Molasse (Hohe Rhonen, Ralligen, Monod and Rochette) Bovey has eleven species in common,—all species which occur in other parts, but two of them (*Dryandroides hakeæfolia* and *D. lævigata*) are especially frequent in Switzerland.

Of the French tertiary floras, it approximates most to that of Manosque in Provence. Here, as at Bovey, the most frequent fern is *Pecopteris lignitum*; and here also are found *Cinnamomum lanceolatum*, *Daphnogene Ungeri*, *Echitonium cuspidatum*, and *Dryandroides lævigata*. The water-lily of Bovey is probably one with the *Nymphæa calophylla*, Sap., of Manosque; but this cannot be determined, as we have only the leaves in the latter case, and the seeds in the former.

In the composition of the soft clay that contains the plants in the 26th bed at Bovey, and in the mode of their deposition in the same, there is great resemblance to the clays of Samland near Königsberg. A further connexion may also be traced through *Gardenia Wetzleri*.

It is remarkable that Bovey has no species in common with Iceland, although the tertiary flora of Iceland belongs to the same period, and two of its species (*Corylus MacQuarrii*, Forbes, and *Platanus aceroides*, Gp.) extend into Great Britain, having been found in Mull, in the Miocene of Ardtun Head. Even the genera are distinct, with the exception of two, *Sequoia*, and *Quercus*, which genera have each a single but distinct species in Iceland and in Bovey. The Bovey flora has a much more southern character, corresponding entirely with that of the Lower Miocene of Switzerland. Bovey had three species of cinnamon, one laurel, evergreen fig-trees, one palm, and large ferns, thus manifesting a subtropical climate.

If we compare the Bovey flora with that of the Eocene beds of the Isle of Wight, we find certainly some points of connexion, but, on the whole, an essentially different character. As connecting points, we may observe that one species (viz. *Laurus primigenia*, Ung.) is common to Alum Bay and Bovey, and, moreover, that the genera *Quercus*, *Ficus*, *Dryandroides*, *Daphnogene*, and *Sequoia* appear in both places, although differing in species. The fact of only one species being found in common at so short a distance —that in the Eocene formations of the Isle of Wight the highly characteristic Cinnamon and Lastræas are wanting—above all, the fact that Bovey has many more species in common with the more remote Miocene formations of the Continent than it has with Alum Bay and Bournemouth, satisfies us that it belongs to a different horizon*.

In this summary we have noticed only the species already known. Among the new species, however, of which I have described twenty-six, several interesting forms are found. The first place belongs to the *Sequoia Couttsiæ*, m., a Conifer, which we can illustrate by branches of every age, and by the cones and seed. It supplies a highly important link between *Sequoia Langsdorfi* and *Sequoia Sternbergi*, the widely distributed representatives of *Sequoia sempervirens*, Lamb., and *Seq. gigantea*, Lindl. (*Wellingtonia*), which latter species are at present confined to California.

Of great interest also are two species of *Vitis*, of which the grape-stones lie in the clays of Bovey. They belong to different species from the tertiary vine of the Continent (*Vitis teutonica*, A. Br.); but it is not improbable that they may be identified with that of Iceland (*Vitis islandica*, m.), though we must leave this indeterminate for the present, as we have obtained only the leaves from Iceland, and only the grape-stones from Bovey. The three remarkable species of fig, the seeds of three new species of *Nyssa* and two of *Anona*, one new water-lily (*Nymphæa*), and many highly ornate *Carpolithes*, are important additions to our knowledge of tertiary plants.

If from the relics of Bovey plants, which are still far from numerous, we attempt to represent the vegetation of Bovey as it existed in the tertiary period, we shall have to sketch it somewhat in the following manner:—The woods that covered the slopes which surrounded the beds of lignite consisted mainly of a huge coniferous tree (*Sequoia Couttsiæ*), whose figure resembled in all probability its highly admired cousin the *Sequoia* (*Wellingtonia*) *gigantea*, Lindl., of California. It had just the same graceful slender appearance in its vernal shoots, thickly studded with leaflets; and the similarity continued in the older shoots and branches, which were clothed with scales. But it presented a distinct character in its shorter leaves, which were even more closely appressed to the shoots, and in its smaller cones. The leafy trees of most frequent occurrence were the cinnamons (*Cinnamomum lanceolatum* and *C. Scheuchzeri*) and an evergreen oak (*Quercus Lyelli*, m.) like those which now are seen in Mexico. The species of evergreen fig were rarer, as were also those of *Anona* and of *Gardenia*. The trees of the ancient forest were evidently festooned with vines, beside which the prickly Rotang-palm (*Palmacites Dæmonorops*) twined its snake-like form. In the shade of the forest throve numerous ferns, one species of which (*Pecopteris lignitum*) seems to have formed trees of imposing grandeur; besides which there were masses of underwood belonging to various species of the genus *Nyssa*, which is at present confined to North America. On the surface of the lake in which were formed the deposits of clay and sand that lie between the lignite-beds, were expanded the leaves of those water-lilies the ornate seeds of which are preserved for our examination.

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* I received lately from Mr. Pengelly a collection of plants from the Tongrian stage of Hempstead (Isle of Wight); it contains four Bovey species, viz. *Sequoia Couttsiæ*, *Andromeda reticulata*, *Nymphæa Doris*, and *Carpolithes Websteri*.

If we inquire further how far the plants help us to a definite view of the course of events by which these lignite-beds were formed, our conclusions will be somewhat of the following kind:—

It is highly probable that at the period of the Lower Miocene the Bovey basin was occupied by an inland lake. The entire absence of freshwater shells, and indeed of aquatic animals generally, is certainly very extraordinary; and so is the absence of fruits of *Chara*, which abound elsewhere in Miocene freshwater deposits; the *Nymphæa* seeds, however, afford positive proof of fresh water. We must not omit to notice that the parts of the basin hitherto explored, and the only parts which are accessible to investigation, lie at a great distance from the hills. Accordingly they were far from the bank, more in the middle of the lake, and, in the case of the lower beds, at a considerable depth. This explains the absence of bog plants, so numerous in other instances, as well as the absence of mammalian relics. These would not have drifted so far out into the lake, and probably they are to be found on the edge of the lignite formation, where the vegetation also may be expected to present a somewhat different character. The lignite-beds of the under series consist almost entirely of tree-stems (probably belonging in great measure to *Sequoia Couttsiæ*); these alternate with masses of a brownish-black clay, the dusky colour of which has doubtless been produced by the decomposition of the softer portions of the plant. No leaves offer themselves for recognition, but here and there twigs and seeds of *Sequoia Couttsiæ*, and little fruits, as *Carpolithes Websteri* and *C. nitens*. The tree-stems, which are here piled one over the other in huge masses (none of them stand upright), and which every here and there stretch their branches and roots in the layer of clay which has covered them up, have apparently been floated hither, not only from the immediate circuit of hills, but doubtless also from greater distances. Such a mass of timber could hardly have been furnished by the former. Accordingly we learn from the structure of these lignite-beds that they did not originate in a tertiary peat-deposit, but from a colluvies of wood uniting in a lake; and hence they differ widely from those of Paudèze, of Hohe Rhonen, of Käpfnach, and other localities of Switzerland. At the same time the lignites of Bovey must have taken a long period in the process of formation, as the repeated alternations of clay-beds sufficiently show.

When a mass of timber and mud had been deposited in the bottom of the Bovey lake, some natural disturbance (whether owing to extensive landslips falling into the lake, or to the river undermining its banks) must have occasioned the contribution of a mass of quartzose sand, which thickly covers the under set of lignites, and which must at the time have helped largely to fill up the lake. Immediately above it lies a soft clay with numerous leaves of plants (the 26th bed), just as they were drifted together from the woods in the fall of the year. It seems, then, that this bed was formed in autumn, and that the plants it contains are due to the driftings of that season; in further confirmation of which, is the frequent recurrence of the seed and ripe cones of *Sequoia Couttsiæ*. Higher up follows the bed with the fern-rhizomes, among which occasionally can be recognized the pinnules of *Pecopteris lignitum*, which, somewhat higher up, amidst the branches of the *Sequoia*, appear in great abundance, being here and there compacted together in dense masses.

Above this bed come strata of clay and comparatively inconsiderable deposits of lignite, which last were all formed from the collection of wood and plants drifted to the spot.

As this Lower Miocene formation is immediately succeeded by quartzose sand with White Clay, we have here a great hiatus. Either the Middle and Upper Miocene, as well as the Pleiocene periods, must have passed without the formation of deposits in this place, or the latter must have been removed during the Diluvial period.

B. *The White Clay.*

While the lignites and their alternating clays at Bovey present us with a vegetation which is subtropical, the plants of the White Clay exhibit a totally different character, and must have had their origin in a period altogether distinct. The collection of Mr. Pengelly contains four species from this formation—three of *Salix* and one of *Betula*; and, what is the most remarkable, none of these appear to me to differ from species now living. The little birch-leaves are not to be distinguished from those of *Betula nana*, Linn., nor the willow-leaves of one species from those of *Salix cinerea*, Linn.; while those of a second species come very near *Salix repens*, Linn., and also resemble strongly those of *Salix ambigua*, Ehrh. So variable is the form of these leaves, that it is hard to fix the species with positive certainty. At all events these leaves prove to us that those white clays must be much more recent than the lignite deposit; while the presence of *Betula nana*, Linn., which is in the highest degree remarkable, is conclusive for a diluvial climate, that is, a colder climate than Devonshire has at the present day; for this dwarf birch is an Arctic plant, which has no British habitat south of Scotland, and which occurs in Mid Europe only on mountains and subalpine peat-mosses. The evidence of the willow-leaves is to the same effect, indicating that at this period Bovey was a cold peat-moor. We may remark that *Salix cinerea*, Linn., is one of the most prevalent species of the diluvial travertine of Kannstatt.

I. *Descriptions of the Miocene Species of Plants.*

I. CRYPTOGAMÆ.

I. FUNGI.

1. Sclerotium, Tode.

1. Sclerotium Cinnamomi, m. (Plate XVI. fig. 17; fig. 19, magnified; diameter magnified, 19 *b*.)

Scl. perithecio orbiculato, duro, plano, margine elevato.

On the leaf of *Cinnamomum Rossmässleri* there are several flat circular umbos. They are 1 millim. in diameter. They are quite smooth and flat in the centre, and surrounded by a very sharp edge.

They very much resemble *Sclerotium pustuliferum*, Heer, which is often found on *Quercus neriifolia* in Oeningen. Of the living species, *Scl. pustula* may be compared with it. Rossmässler has figured a closely resembling, but somewhat larger fungus, in his 'Beiträgen zur Versteinerungskunde,' taf. 8. fig. 27.

2. Sphæria, Hall.

2. Sphæria socialis, m. (Plate XIV. fig. 13 *c*; fig. 13 *c c*, magnified.)

Sph. peritheciis congregatis, minutissimis, orbiculatis, ostiolo rotundato pertusis.

In the 17th bed at Bovey.

There are many circular and convex little bodies close together on a leaf of *Dryandroides lævigata*, Heer. In the centre they are furnished with a pretty large aperture.

3. Sphæria lignitum, m. (Plate IV. fig. 1; figs. 2 & 3, magnified.)

Sph. peritheciis gregariis, liberis, conicis, nigris, apice nitidis, papillatis, ostiolo minuto, orbiculato.

I found this *Sphæria* on the bark of several branches, which perhaps belong to *Sequoia Couttsiæ*. They were lying in the 26th bed, beside some young branches of *Sequoia*. The perithecia form little black warts, which are clustered together in great numbers; the largest ½ millim. in diameter; many of them are much smaller, and appear as black points. The largest of them are slightly conical, and furnished on the top with a very small though distinctly separated cicatricule. When this cicatricule falls away, a small aperture is left. In many of them a transverse slit has originated near the base, and the upper part of the perithecium has fallen away; thus we have a large aperture, surrounded by the pretty thick coat of the perithecium.

This belongs to the group of *Sphæriæ pertusæ*, Fries (Systema Mycolog. ii. p. 460), and has a great resemblance to *Sphæria umbrina*, which, however, is much larger and flatter.

II. FILICES.

1. Lastræa, Bory, Alex. Braun. (*Phegopteris*, Mettenius.)

4. **Lastræa (Goniopteris) Stiriaca.** (Plate V. figs. 12–15.)

L. fronde pinnata, pinnis linearibus, prælongis, grosse crenatis serratisve, nervis secundariis e nervo primario angulo subacuto egredientibus, pinnatis, nervis tertiariis utrinque plerumque 6–7, curvatis, subparallelis, angulo acuto egredientibus, soriferis; soris rotundatis, biseriatis.

Heer, Flora Tertiaria Helvetiæ, i. p. 31; iii. p. 151; pl. 6, 7, 143, figs. 7 & 8.

Polypodites stiriacus, Unger, Chloris Protogæa, p. 121, pl. 36.

This is the tertiary fern which has the widest distribution. It appears rarely in the Upper Molasse, however (on the Albis, in Parschlug and Sarzanello), but very often in the Aquitanian stage of the Lower Miocene formation—thus at Monod, the Paudèze, Hohen Rhonen, &c., in France at Ménat, and in Italy at Cadibona. Several portions of leaves have been found at Bovey, the determination of which is undoubted. The leaf figured in fig. 15 represents a pinnule in almost its whole length; the other figures represent parts of leaves, the nervation of which is well preserved (Plates V. fig. 12; VI. fig. 8). The specimen Plate V. fig. 14 is a portion of a leaf with the rachis, on the side of which the pinnules are attached. The pinnule is long and narrow, with parallel sides, deeply toothed, the teeth bent towards the apex; their long side forms an arch, the sinus is acute. The principal nerve of the pinnule is strong, the secondary nerves are fine, springing at acute angles and forming a slight arch; from each secondary nerve spring, on the inner side five or six, and on the exterior side six or seven, but seldom eight, tertiary nerves. They are strongly bent upwards, and united exactly in the same manner as in the specimens I have described in the 'Flora Tertiaria Helvetiæ' (vol. i. p. 31). At Bovey, hitherto, only sterile leaves have been found, whilst Monod has furnished pinnæ covered with sori (cf. Plate V. fig. 13). The sori are in the middle, or a little outside the middle of the tertiary nerves; they are round, small, and ranged in two lines, converging towards the apex. We see, from the specimens discovered at Monod, that this species was a very large one. The leaves attained probably a length of 3 feet and a diameter of at least 1 foot. The pinnules are very distant from each other at the base of the leaf, whilst above they approach and get gradually shorter. Most of the specimens are from the 17th bed of Bovey, I saw, however, one in the clay of the 26th bed.

Lastræa Stiriaca most resembles *L. prolifera*, Kaulf. (*Phegopteris prolifera*, Metten.), of tropical America, and belongs to the genus *Lastræa* (div. *Goniopteris*), as Alex. Braun has established it (cf. Flora Tertiaria Helvet. i. p. 30, and iii. p. 150).

5. **Lastræa Bunburii**, m. (Plate XII. fig. 1, *b*; magnified, *c*, *d*.)

L. fronde pinnata (?), pinnis linearibus, apicem versus angustatis, argute serratis, nervis secundariis flexuosis, e nervo primario angulo subacuto egredientibus, pinnatis, nervis tertiariis utrinque 2–4, subflexuosis, curvatis, angulo acuto egredientibus.

Only a portion of a leaf, of 71 millims. in length; it occurred in the clay of the 26th bed. At the base it was probably 19 millims. in diameter; towards the apex it gradually tapers; therefore it must probably have had a long apex, which however is not preserved. It very much resembles the former species, but differs by the tapering form, the smaller and very acute teeth, and the fewer tertiary nerves, which are undulated. A comparison with fig. 4, pl. 8 of the 'Flora Tertiaria' shows that it is not the exterior part of the former species. It approaches more to *L. helvetica*, Hr. (Flora Tertiaria, i. p. 33, iii. p. 151), in the tapering of the pinnules, notwithstanding the fewer tertiary nerves and the undulated secondary nerves. It differs from *Aspidium dalmaticum*, Ett., in the smaller teeth, and fewer tertiary nerves.

The margin is provided with very small and sharp teeth, which are very much bent towards the apex. The secondary nerves are thin, strongly undulated, and have on the under side mostly four, sometimes but three, on the upper one two or three tertiary nerves, which are also undulated. The lowest one is united with the lowest of the next secondary nerves, and forms with it a triangular acute areole, out of which springs a branch that advances to the next sinus. A little higher it is joined by two united tertiary nerves, also at an acute angle, and immediately under the sinus another one. This nerve directed to the sinus is also undulated.

2. PECOPTERIS, Br.

6. PECOPTERIS (HEMITELIA?) LIGNITUM, Gieb. (Plate IV. figs. 4–6; V. figs. 1–11; VI. figs. 1–7, magnified.)

P. fronde pinnata, pinnis linearibus, longis, apice valde attenuatis et acuminatis, basi plerumque breviter petiolatis, profunde inciso-serratis, nervis tertiariis furcatis, inferioribus valde curvatis, sinum attingentibus.

Pecopteris lignitum, *P. crassinervis*, *P. leucopetræ* et *P. angusta*, Giebel, "Paleontolog. Untersuchungen," Zeitschrift für die gesammten Naturwissenschaften, 1857, p. 305, pl. 2. fig. 2.

Aspidium lignitum, Heer, Beiträge zur nähern Kenntniss der sächsisch-thüringisch. Braunkohlenflora, p. 424, pl. 9. figs. 2 & 3.

Aspidium Meyeri, Ludwig (non Heer!), Palæontograph. viii. 2. p. 63, pl. 12. fig. 3.

This is the commonest fern at Bovey; it and *Sequoia Couttsiæ* are the plants most commonly met with in this locality; the petioles and pinnules are heaped up in the 17th and 26th bed. They are only separated by thin layers of clay. On dissolving this, one is able to take the leaves out of it and preserve them in fluid (spirit, glycerine, water). They decompose in the air.

This species had a large distribution in the tertiary period, but is confined to the

Tongrian and Aquitanian stages. It has been found at Weissenfels in Saxony, at Salzhausen and Münzenberg, at Thôrens in Savoy, and at Manosque in Provence.

Hitherto no perfect leaves or pinnules have been found at Bovey, but so many portions of pinnules that one can easily put together the entire pinnule, as we have tried to do in Plate V. fig. 8. The pinnule is in length 173 millims., its extreme breadth 21 millims.; it gradually tapers towards the apex, and forms a long sharp point (Plate V. figs. 2–4, and magnified fig. 1). The pinnule is also narrower at the base than in the middle; at least several pieces evidently belonging to the base are narrower than those from the middle of the pinnule (fig. 5). The pinnule is shortly petioled, and has often unequal sides at the base. There are many such pinnules around a finely striated rachis; portions of which latter common rachis are often found (cf. Plate IV. figs. 5, 4 *a*, & 8) between the pinnules, and in several cases I have seen the lateral pinnules attached.

The pinnules are of a strong, almost leathery consistence, and, examined with a lens, they appear to be finely punctate. Their margin is deeply toothed, the broad portions in the middle of the pinnule are nearly pinnatifid, the teeth on the outer margin smaller, and closer together. All these teeth are strongly bent towards the apex; the long side forms a strongly-curved arch; they are entire, and provided at the tip with a distinctly separated little tooth. The midrib is pretty strong; the secondary nerves spring at the base of the leaf in slightly acute angles, and in more acute ones in the upper narrower part of the pinnule. They are mostly more or less curved, and on each side they send forking tertiary nerves, on the upper part (nearer the tip) mostly one or two less than on the lower one. The broad pieces of pinnules have on the lower side seven or eight tertiary nerves; the number lessens nearer to the tip, as the pinnules gradually taper (we count there 6, 5, 4, 3, 2), and quite near the tip they are undivided (fig. 1). Each of the tertiary nerves soon divides into two branches, which do not again divide; only the exterior ones remain entire. Those tertiary nerves are everywhere equally strong, and sometimes the fourth or fifth advances to the margin, whilst the following one is again forking. The lowest ones are very strongly curved, and enter the sinus always between two teeth. The lowest tertiary nerves do not generally join the nerve of the neighbouring pinnules (Plate VI. figs. 1, 4 & 5), or only in the sinus, forming a very acute-angled triangle (figs. 3 & 7). In some cases they unite like *Goniopteris*, already a little lower (Plate VI. fig. 2), forming several very acute-angled arches. The tertiary nerves mostly spring from the secondary; but sometimes a fine forking nerve immediately springs from the principal nerve (Plate VI. figs. 1–5), and runs to the sinus of the teeth.

A portion of a leaf very different in the nervation is figured in Plate VI. fig. 6 (magnified). The tertiary nerves spring at very acute angles; they are very numerous, and some of them are twice forked. The teeth seem to have been narrower and longer. This fragment may belong to another species, but is too imperfect to pronounce any opinion upon. Beside the pinnules of the leaves, we often find at Bovey circinate young shoots of ferns (Plate V. figs. 9, 10 & 11), which probably belong to the species in question, as being the commonest one.

Professor GIEBEL, who first established this species, has given it four names: his *Pecopteris leucopetræ* represents the apex of the leaf, *P. angusta* a portion of the pinnule a little below the apex, where the tertiary nerves spring at acute angles, and *P. lignitum* and *P. crassinervis* the broader lower part of the pinnule.

LUDWIG has confounded this species with *Aspidium Meyeri*, Heer. The portion of a leaf from Münzenberg, figured by him in pl. 12. fig. 3 of the 'Palæontographica,' entirely differs from *A. Meyeri*, in the shallower incision and different nervation. It belongs to *P. lignitum*. It seems to me that the portion of a leaf figured by him in pl. 10. fig. 2, belongs to another species.

I have formerly assigned this fern to the genus *Aspidium*, because the secondary nerves are usually forked, and the tertiary nerves often jointed like *Goniopteris*; but a close examination of the numerous and well-preserved fragments from Bovey has convinced me that they do not belong to *Aspidium*. The pinnules had a hard, nearly leathery structure; and the peculiarly curved lower tertiary nerves, which run in large arches, differ from *Aspidium*, and very much remind one of *Hemitelia*. The tertiary nerves of the Hemitelias are most of them jointed by small nervules; but still there are species in which this is not the case (ex. gr. *H. integrifolia* and *H. speciosa*), and in *H. Karsteniana* (cf. Mettenius, Icones Filicum, pl. 29. fig. 2) there is a variety the nervation of which has more likeness to that of *Pecopteris lignitum* than to any other species of fern known to me; therefore the species in question probably belongs to the genus *Hemitelia*. It may, however, be better in the meanwhile to preserve the name *Pecopteris* till the fruits are found, which certainly will be soon, this species being so common at Bovey. I have, however, sought in vain for sori amongst many hundreds of pinnules. Sometimes little round spots are seen which look like sori (Plate IV. fig. 4 *d*); but a careful examination shows that they are accidental markings, some of them upon the tertiary nerves, and others beside them.

In the 25th bed at Bovey (rarely in the 17th) we often find large rhizomes quite covered with petioles, which, I suppose, for the following reasons, to belong to *Pecopteris lignitum*.

1. In several pieces, I found between the petioles the pinnules of *Pecopteris lignitum*, though not attached.

2. In the lignites of Salzhausen quite similar rhizomes are found with pinnules of *Pecopteris lignitum* (cf. Ludwig, in the 'Paleontographica,' viii. p. 64, pl. 10. fig. 3); therefore LUDWIG has compared it with this species (his *Aspidium Meyeri*).

3. The petioles are striated in the same manner as the petioles which are so often lying between the pinnules of *Pecopteris lignitum*, and which undoubtedly belong to one plant, as in some cases I saw them attached (Plate IV. fig. 4).

4. The rhizomes and the petioles are mostly curved towards one side; therefore the

rhizomes probably lay horizontally on the earth, and the leaves arched upwards, as we see in existing ferns.

The stems, and the petioles which cover them, are converted into coal; therefore a microscopic examination is not possible. The considerable thickness of the organs surrounding and covering the stems shows us that they are petioles, and not leaves. Though they are very much compressed, the thickness of the mass of coal is nearly always several millims.

The large specimens remind us directly of the pinnated leaves of palms (Plate VII.). On examining them minutely, we see that the supposed pinnules are not fastened in two rows on the rachis, but that they are placed around it spirally; therefore they cannot be pinnules of leaves; they are organs fastened on a stem; and as they are tapered at the base, and inserted on the stem with a tapering but not sheathing base, they cannot at all events be the leaves of a monocotyledonous plant. The leaves of ferns are inserted in that manner on the stem, and taper also sometimes towards the base. In most of the Aspidieæ, Asplenieæ, and Cyatheæ the petioles are continuous with the stem; they remain after the withering of the leaves, and form a thick and dense cover over the rhizome, as they do in the Bovey plant. It is remarkable that roots are seldom seen on these rhizomes; but in several specimens thread-like bodies can be seen between them, which probably were fibrils; and there are, further, some specimens which indicate that the numerous fine undulated striæ, which at some places are lying in heaps, are probably hairy scales which have covered the petioles.

The largest specimen is 7½ decim. long and 2 decim. broad. It is pretty strongly curved. The petioles are lying in heaps one upon another, and therefore must have covered the stem. In some specimens the stem is denuded here and there. It is quite converted into coal, and it is therefore as impossible to examine its anatomical structure as that of the petioles. These are of a considerable length, and always irregularly broken; their length therefore varies. I have collected great numbers of specimens at Bovey, and hoped to have been able to find the connexion of the petioles with the pinnules of *Pecopteris*, but was unsuccessful, though these rhizomes are in heaps in the 25th bed. The petioles gradually taper towards the base, which is rounded; they never sheath. Many specimens distinctly show that the petioles are not distichous, but are imbricated all round the stem. They are compressed, but the edges are defined.

At the same place there are portions of rhizomes provided with the cicatricules of roots (Plate VII. fig. 3). These are orbicular, 3 millims. in diameter, and consist of an elevated margin, surrounded by an orbicular depression, or, instead of this, they present a central wart, evidently originating from the central fibre. They are in pretty large numbers together, without being ranged in fixed order. The stems of living ferns have similar cicatricules of roots. The *Stigmaria*? of Altsattel, according to ROSSMÄSSLER*, probably represents also a portion of the stem of a fern with the cicatricules.

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* Beiträge zur Versteinerungskunde, pl. 12. fig. 58.

7. **Pecopteris Hookeri**, m. (Plate VII. fig. 3.)

P. pinnis elongato-lanceolatis, anguste serratis, nervis secundariis furcatis.

I have seen only a drawing (Plate VII. fig. 3) which Mr. Fitch has made. He assured me that the nervation and the natural size of the leaf were truly represented. The leaf seems to be lost; for it could be found neither in London nor at Mr. Pengelly's, at Torquay. It consists of a pinnule*, the base and point of which are wanting. It is toothed, the teeth sharp and bent towards the apex, the secondary nerves partly alternate, partly opposite, each of them divided into a simple fork. The branches of the fork run to the teeth.

II. PHANEROGAMÆ.

A. Gymnospermæ.

Order CONIFERÆ.

Fam. Abietineæ, Rich.

1. Sequoia, Endl.

8. **Sequoia Couttsiæ**, m. (Plates VIII., IX., X.)

S. ramis alternis, rarissime verticillatis, ramulis junioribus elongatis, gracilibus; foliis squamæformibus, imbricatis, subfalcatis, medio dorso costatis, basi decurrentibus; strobilis globosis vel subglobosis; squamis peltatis, medio brevissime mucronulatis, rugosis; seminibus alatis, compressis, nucleo paulo curvato.

This and *Pecopteris lignitum* are the commonest plants of Bovey, and their stems certainly contribute the greatest amount of lignite. Larger and smaller branches of this tree occur in the 17th and 26th beds of the clay. Entire cones (as represented in Plate VIII. figs. 1, 14, 16 & 18), seeds, and scales of cones have been found in great numbers. It is certain that the cones and seeds belong to one plant; for they not only agree with those of *Sequoia*, but in several cases I have seen the seeds lying in their natural position under the cone. But it might be questioned if all those branches the principal forms of which are represented in Plates VIII. and IX. belong to this same tree, because the young twigs so closely resemble those of *Glyptostrobus europæus*. A very minute comparison, however, of many specimens has persuaded me that this is not the case, and that all the figured branches and cones belong to one plant. In comparing the leaves of the twigs which bear the cones (Plate VIII. figs. 14, 16 & 18), we see that their form agrees with the loose twigs. As the principal character of these leaves, we may observe that they are nearly always somewhat falcate (cf. Plate IX. figs. 14–20). This is not the case with *Glyptostrobus europæus* (cf. Plate IX. fig. 49, magnified fig. 49 *b*, where a twig of *Glyptostrobus* of the Hohe Rhonen is represented for comparison). The adnate scale-like leaves are straight in *Glyptostrobus*, or only somewhat curved outwards and obtuse, as in *Glyptostrobus heterophyllus*, Br. The spreading leaves are often provided with an acute and usually straight point, and, but seldom, a little curved; when this is the case, they have at all events a great likeness to our *Sequoia*.

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* This form very much reminds us of *Lastræa Bunburii*, the nervation of which is however quite different.

As we have the branches, fruits, and seeds of this tree, the determination of the genus is undoubted. It resembles in all its principal points *Sequoia*, Endl. It has decurrent leaves, globose cones with peltate scales. They are provided on the surface with wrinkles radiating from a small mucro.

Several flat-winged seeds are lying under the scales. The scales and seeds very much resemble those of *Sequoia sempervirens*, Lamb., of California (cf. this cone, Plate IX. fig. 48, and the seeds of this species, fig. 47, magnified 47 *b*); but the nucleus of the seed is somewhat curved in the fossil species. The leaves are quite different, those of the sterile branches of *Sequoia sempervirens* being distichous and long linear, almost as in *Taxus baccata*, Linn. The *Sequoia Couttsiæ* approaches *S. gigantea* (*Wellingtonia*, Lindl.) in the form and position of the leaves, but differs in the much smaller cones. The Bovey species is in some measure intermediate between the two existing species.

In comparing the species of Bovey with the tertiary species of *Sequoia*, the *S. Langsdorfi*, Br., will be first taken into consideration. The cones are very similar (cf. Flora Tertiaria Helvetiæ, pl. 21. fig. 4 *d*, pl. 146. fig. 16; and Ludwig, Palæontographica, Band viii. pl. 15. fig. 1); but this species has the leaves of *S. sempervirens*. Our species still more resembles *S. Hardtii* *, the scales of the cones being of the same length and form, but Unger and Ettingshausen describe the cones as subconical, and the seeds as provided with a mucro; further, the leaves of the fertile twigs are more acute, and those of the sterile ones are linear and spreading. The Bovey species differs from *S. Sternbergi* (*Araucarites*, Gp.) in the much more slender twigs, and the different construction of the leaves. It differs from *S. Ehrlichi*, Ung., in the shorter leaves and the globose cones.

If we compare all the Sequoiæ now known, we have to place them in the following manner:—

1. *Sequoia gigantea*, Lindl.; California.
2. *Sequoia Ehrlichi*, Ung.; tertiary formation near Spital in Austria.

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* *Cupressites Hardtii*, Goeppert, Monogr. der Fossilen Coniferen, p. 184.

Cupressites taxiformis, Unger, Chloris protogæa, p. 18, pl. 8. figs. 1–3, pl. 9. figs. 1–4.

Chamæcyparites Hardtii, Endl. Synopsis Conifer. p. 277; Ettingshausen, Flora von Haering, p. 35, pl. 6. figs. 1–21.

Endlicher and Ettingshausen have wrongly referred this species to *Chamæcyparis*; the leaves of which genus are opposite, and ranged in four rows round the branch, whilst they are alternate in *S. Hardtii*, as in *Sequoia*; the cones of *Chamæcyparis* are much smaller, and the seeds have a thicker nucleus, the base and point of which are not surrounded by the thin wing. This species has no doubt been referred to *Chamæcyparis* by Unger from a comparison with *Cupressus thurifera*, Humb. et Bonpl. (*Chamæcyparis*, Endl.).

3. *Sequoia Sternbergi*, Gp.[*]; has a wide distribution in the Miocene formation, from Senegaglia to Iceland.

4. *Sequoia Couttsiæ*, Hr.; Bovey.

5. *Sequoia Hardtii*, Gp.; Haering and Armissan.

6. *Sequoia Langsdorfi*, Br.; spread over the whole Miocene formation, in Italy, Germany, Switzerland, France, Isle of Mull, Greenland, Bear-lake River, Vancouver Island, from the Unga at the shore of Aleski, Russia near Orenburg.

7. *Sequoia sempervirens*, Lamb.; California.

The genus *Sequoia* probably begins in the cretaceous formation; for *Geinitzia* (*Cycadopsis*, Deb.) is so nearly related to *Sequoia*, that, according to Dr. DEBEY, it can scarcely be separated from this genus, and may be considered as the predecessor of it. This genus most abounded in the Miocene time; it was spread over the whole Continent as far as we know. In the present creation we have but two remains of this type, both found only in California. These two living species represent the two extremes of all the known forms. Of the fossil species, *S. Langsdorfi* especially approaches to *S. sempervirens*, and *S. Ehrlichi* and *S. Sternbergi* to *S. gigantea*. *S. Couttsiæ* is the intermediate species between these two principal types.

I now proceed to describe the Bovey specimens.

The annual twigs (Plates IX. figs. 9–20; VIII. and IX. figs. 7 & 8, magnified) are very slender, often of considerable length (figs. 14–16), without producing lateral twigs. The leaves cover the twigs like scales, which are mostly very close together (Plate IX. fig. 10); on the long twigs they are more distant. At the base of the young shoots they are always closer and shorter (fig. 7), a little more outwards they are more distant. The leaves are alternate, though sometimes two are nearly opposite, but never exactly so. All the leaves are decurrent at the base. The very short scale-like leaves are somewhat falcately curved (cf. Plate IX. fig. 13, magnified), and still more so are the leaves which are more distant from one another (Plate IX. figs. 14, 15 & 17). These leaves are acuminate, and the point is curved outwards (Plate IX. fig. 14 *b*, somewhat magnified). Amongst the great number of twigs I have seen, there was only one with much longer linear leaves (Plate IX. fig. 12, magnified fig. 12 *a a*) than they commonly appear in *Sequoia Hardtii*. Twigs with such long leaves therefore must be very rare. The small portion of a twig which is represented in fig. 9 (magnified) forms the intermediate form of this leaf. The leaves are always rigid, and provided at the back with an elevated edge, which runs to the apex of the leaf. The biennial twigs (Plate IX. figs. 1 & 2) are much thicker and also quite covered with leaves, which are scale-like, applied to the stem; they are broader than the leaves of the annual twigs, and closer together at the base of the twigs. They show at different places the scars on which the alternate shoots have been fastened. I only saw one branch with whorled twigs (Plate VIII. fig. 13). The branches of three years (Plate VIII. figs. 9 & 11) are 5 to 6 millims in breadth. We see on them numerous cicatrices of branches, which indicate the insertion of the twigs. The leaves are nearly of the same size as those of the biennial ones; they are, however, not so close together; they are scaly, adhering to the twigs, and the epidermis is provided with many longitudinal wrinkles. These twigs are thicker at the base (Plate VIII. fig. 11). As there are many twigs found thus thicker at the base, they appear to have separated themselves very easily from the stem at the place of insertion. The leaves disappear on still thicker and therefore older twigs, and only small scars remain on the bark. Beside these branches of different ages, there are trunks which probably belonged to this tree.

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[*] I have already tried to show, in my 'Flora Tertiaria Helvetiæ,' iii. p. 317, note, that *Araucarites Sternbergi*, Gp., belonged to *Sequoia*. MASSALONGA has given, in his 'Specimen Photographicum,' pl. 21, a photograph of his *Araucarites venetus* of Chiavon. He said that the leaves and twigs were not different from those of *Araucarites Sternbergi*; he took it for a different species, because he thought, with UNGER and ETTINGSHAUSEN, that the cone presented under the name of *Araucarites Gœpperti*, St. (Sternberg, Pflanzen der Vorwelt, pl. 89. fig. 4; Goeppert, Fossile Coniferen, pl. 44. fig. 2), was to be referred to *A. Sternbergi*. But we have shown, in the 'Flora Tertiaria,' that there are no sufficient reasons for it; and the circumstance that cones are found, in Chiavon, on a twig which is not to be distinguished from *A. Sternbergi*, and also immediately beside similar twigs in Iceland (quite different from *A. Gœpperti*), confirms this opinion. The cone of Chiavon is much compressed, and lies in a lateral position, while the cones of Iceland represent the transverse section (as do the pieces represented by STERNBERG, 'Flora der Vorwelt,' ii. pl. 57. figs. 1–3, as *Steinhauera subglobosa*, Presl, which, according to my opinion, belong to this species). The scales of the cones are small and in great numbers, and very different from *Araucaria*, while the cone figured by MASSALONGA has a great resemblance to that of *Sequoia gigantea*. The seeds represented as *Steinhauera* quite agree with *Sequoia*.

The cones are solitary or in pairs (Plate VIII. fig. 14, restored fig. 15), on rather slender twigs quite covered with scaly leaves. They are globose (Plate VIII. fig. 16, restored fig. 17; fig. 14), or shortly oval (fig. 19), from 15 to 24 millims. in length, and from 15 to 17 millims. in breadth. The scales are peltate, the footstalk is short, and seems to be central (Plate IX. figs. 29, 30 & 33); the upper side is polygonal, but this form is not constant; in the middle is a very short mucro, from which originate several wrinkles that radiate to the margin; the surface is therefore pretty roughly wrinkled. Cones in which the scales are closed are rare (Plate VIII. figs. 14, 16 & 18). They must have been enveloped by the clay when still fresh. They are often spread open and the scales separated from one another, and the spaces filled with clay (Plate IX. figs. 27 & 28); or we have but solitary scales or portions of cones (Plate IX. figs. 29–35).

There are several seeds beneath every scale (Plate IX. fig. 25); they are also very often scattered between the twigs. The seed is usually 5 millims. long and 3½ millims. broad, and flat; it is somewhat emarginate at the point of insertion, obtusely rounded and a little tapered towards the tip. The nucleus is somewhat curved and pretty flat. It is surrounded by a flat wing (Plate IX. figs. 37–41; fig. 41 *b*, magnified).

In the lignite of Bovey both small and very large pieces of resin are found, which were probably secreted by the *Sequoia Couttsiæ*.

The lignite of Bovey contains very large stems, the zones of which are mostly distinct and crowded; in several stems I could count a hundred of them. One can easily split them longitudinally; but they become quite hard and brittle in the air, and crumble if cut. They are then brown or black. The microscopical examination did not give me satisfactory results. I certainly recognized the elongated woody fibres, but in most cases I was not able to distinguish the structure of their walls, which is very obscure. However, in some cases I saw pores, which are ranged in one row (cf. Plate XX. figs. 8 & 9), and, further, the medullary rays, which are formed from a single row of cells (Plate XX. fig. 8). There is no trace of spiral or reticulated vessels. The structure of the medullary rays and of the fibres proves it to be coniferous wood. As *Sequoia Couttsiæ* is the only coniferous tree hitherto found in the lignite-beds of Bovey, and was the commonest tree of that country, it is very probable that most of the wood belonged to it.

B. Monocotyledones.

Order I. GLUMACEÆ, Bartl.

Fam. I. GRAMINEÆ, Juss.

1. PHRAGMITES, Trin.

9. PHRAGMITES ŒNINGENSIS, A. Br.? (Plates XIII. fig. 1 *d*; XIV. fig. 13 *a*; and XVII. fig. 2.)

Phr. foliis latis, multinervosis, nervis interstitialibus tenuissimis.

Heer, Flora Tertiaria Helvet. i. p. 64, pl. 22. fig. 5, pl. 24.

Only some small parts of leaves; the determination is therefore uncertain. We observe very slender secondary nerves between the strong longitudinal nerves. We can count twelve of them, all equally strong, between two longitudinal nerves, while in *Phr. œningensis* the median nerve is always a little stronger. In the same layer (in the 17th bed of Bovey) there are also some indistinct remains of culms, which probably belong to these fragments of leaves; likewise the pieces figured in Plate XVII. fig. 2, which all represent horizontal sections of culms. Fig. 2 *a* represents the section of a a knot, where, as in *Phragmites communis*, we have a middle part, which appears as a circular umbo, and around it the wall of the culm.

2. POACITES, Br.

10. POACITES, sp. (Plate XVII. fig. 3.)

Bovey (Dr. Falconer).

It is a thin, finely striated grass-culm, on which we perceive a knot. It is $2\frac{8}{10}$ millims. in breadth. It is not sufficient for a more exact determination, but seems to prove that small grasses existed in that country.

Fam. II. CYPERACEÆ, DC.

3. CYPERITES, Hr.

11. CYPERITES DEPERDITUS, m. (Plate IX. fig. 54.)

C. fructibus parvulis, ovatis, apice acuminatis, tenuissime striolatis.

In the 26th bed of Bovey; fragments only.

Under the name of *Cyperites*, I have comprised in my 'Flora Tertiaria' those remains (leaves, culms, and fruits) belonging to plants of the family of the Cyperaceæ which it is not possible now to refer to any genus. The fruits in question very much resemble those of *Carex*, and belong probably to this genus. They are like those of *Carex recognita*, Hr., from Rochette. The fruit is 4 millims. in length, and at the base 2⅖ millims. in breadth; it is there obtusely rounded, but tapered and acuminate at the apex. It is provided with very fine longitudinal striæ.

Order II. PRINCIPES, Linn.

(PALMÆ.)

1. PALMACITES, Hr.

12. PALMACITES DÆMONOROPS. (Plates XI., IV. figs. 7-15.)

P. spatha coriacea, longitudinaliter tenuissime striata granulataque, aculeata, aculeis crebris seriatim in lineis oblique transversis conjunctis, compressis, subulatis, rectis, simplicibus, binis, trinis, vel ad summum senis, adpressis; caudice gracili, aculeato, fasciculis vasorum rigidis, interne planis vel sulco exaratis.

Palæospathe Dæmonorops, Unger, Sylloge Plantar. Fossil. p. 9, pl. 2. figs. 9–12.

Chamærops teutonica, Ludwig, in Meyer's Palæontogr. viii. p. 86, pl. 20. figs. 2 & 3.

Pretty common in the clay of the 26th bed of Bovey.

Chiefly the prickles are found at Bovey. They are black as coal, brilliant, very thin, and taper to a fine point. Their length varies from 4 to 50 millims. The longest are only 3 millims. in breadth at the base (cf. Plate IV. fig. 13). They are flat, and provided with a very shallow longitudinal depression (Plate XI. fig. 9 *b*, a specimen highly magnified), which in some cases becomes almost a furrow. There are mostly three of them together (Plates XI. fig. 1, and IV. figs. 11 & 15), and the median one is the longest (Plate XI. figs. 2, 10 & 11, magnified). Sometimes there are but two together, or they are single; or, on the contrary, there are four, five (Plate XI. fig. 3), or more prickles forming a group. In many pieces I am persuaded that they are not fastened on the margin of an organ, but pretty regularly distributed on a plane surface. Therefore they cannot be simple prickles of the petioles of leaves, as of *Chamærops*, for which LUDWIG has wrongly taken them, as I was convinced on looking at the pieces represented in Plate XI. fig. 1, and still more when I washed them in water. We see then that the bundles of prickles are fastened on and pressed against a very finely striated plane surface, which is provided with minute warts (Plates XI. fig. 7, and IV. figs. 11 & 12). They are broader at the base. The form of these prickles, their position (mostly three together, and the median of them the longest), and their direction (all are directed forwards and pressed against the surface) agree so well with the organs represented by **Unger** from Laubach in the Wetterau, and by **Ludwig** from Salzhausen and Hessenbrucken, that we may be persuaded of their belonging to the same plant. **Unger** compares these prickles with those which appear on the spatha of *Dæmonorops*. We have indeed in *D. polyacantha*, Martius (Palmæ, pl. 160), and *D. melanochætes*, Blume (Martius, pls. 117 & 125), very similar flat prickles, which are broader at the base. There are often three together, the median one of which is also the longest. As at Bovey, these bundles of prickles are often fastened on a flat, spreading, finely striated organ, which is several millims. in thickness, which may be easily taken for a spatha. But it is quite unsuitable to found the name of the genus upon this spatha, and to describe this plant as *Palæospathe*, for we find the same prickles also attached to the stems. I have found at Bovey, in the 26th bed, the stem of a palm, on which such a bundle of prickles was attached. Unhappily it was ruined on the journey. On the contrary, several of these stems, which I collected in the same layer containing the prickles, have remained entire. Some of them are represented in Plate IV. figs. 7–10. They are from 15 to 17 millims. in thickness, and consist of a bundle of fibres which are converted into coal, and appear like brilliant coal-black threads. Each fibre (or bundle of vessels) is flat on the inner side, which is turned towards the centre of the stem, or furrowed longitudinally; on the outer side it is convex; it represents, therefore, on a transverse section, more or less, a half circle or a crescent. These fibres are in some pieces close together, and in others further apart; the latter are probably from the middle, and the former from the periphery of the stem. Some of the fibres attain a thickness of 1 millim., but many are much thinner. In many pieces these bundles of vessels form a stem (cf. figs. 8 & 9). Sometimes they are free, and appear like long black fibres scattered in the clay; or beside the united ones we see numerous scattered bundles (cf. Plate IV. figs. 7 & 10). These organs very much resemble the bundles of vessels which appear in the lignite of Käpfnach (*Palmacites helveticus*, Flora Tertiaria Helvetiæ, p. 94, pl. 40. fig. 1); but such thick pieces have not hitherto been found at Bovey. The stems were thin, and probably the petioles may have been so too. The construction of the bundles of vessels shows indeed that they belonged to a monocotyledonous plant, and confirms the conclusion derived from the prickles attached to the spatha.

I found at the same place several fragments of leaves (Plate XVII. fig. 1) which certainly belong to a monocotyledonous plant, and perhaps, therefore, to the species in question. They are broad portions of leaves, with numerous fine longitudinal parallel striæ of equal strength; nine of them occupy 1 millim. They are therefore very close.

Mr. **Pengelly** found a fruit at Bovey* which probably belongs to the plant in question. It is oval (cf. Plate IX. fig. 50, magnified figs. 51–53), 13 millims. in length and 10 millims. in breadth, and covered with scales. It resembles the fruit of the Rotang palm; and as the prickles and the construction of the stems point to these palms, we may combine these organs, and conclude that this palm grew at Bovey. In connexion with this I may mention that large pinnatifid leaves (cf. Flora Tertiaria Helvetiæ, iii. pl. 149), which belong to a Rotang palm, have been found at Oeningen. I have described them as *Calamopsis*. The palm of Bovey belongs perhaps to this genus; but I thought it better to place it in the collective genus *Palmacites*, which contains the different organs of palms which cannot yet be ranged in a fixed genus. These prickles have not been found at Oeningen up to the present time; and the petioles of *Calamopsis* are without prickles. Similar black prickles, however, appear in different genera of palms (for instance *Bactris*), but they are certainly most frequent in the group of the *Calameæ*, Kunth (*Lepidocaryinæ*, Mart.).

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* I have seen only a drawing of this.

C. Dicotyledones.

Coh. I. *APETALÆ.*

Order I. AMENTACEÆ.

Fam. I. CUPULIFERÆ, Rich.

1. QUERCUS, Linn.

13. **QUERCUS LYELLI**, m. (Plates XII. figs. 2–9; XIII. figs. 1–4; XIV. fig. 12 *b*; XV. figs. 1 & 2; XVII. figs. 4 & 5.)

Q. foliis subcoriaceis, petiolatis, lanceolatis vel oblongo-lanceolatis, basi attenuatis, margine undulatis, apice acuminatis, nervo primario valido, recto, nervis secundariis numerosis, curvatis, apice furcatis, ramulo superiore margini valde approximato.

Phyllites cuspidatus, Rossmässler, Beiträge zur Versteinerungskunde, p. 36, pl. 9. figs. 38 & 39.

It frequently appears in the 17th bed at Bovey.

Three forms are distinguishable:—1. narrow lanceolate leaves, which are strongly tapered at the base, and the margin of which is slightly undulated (Plates XIII. fig. 1 *b*, *c*; XII. figs. 3 & 8); 2. narrow leaves, with almost parallel sides in the middle (Plate XIV. fig. 12 *b*); 3. broad leaves, which are distinctly undulated at the margin (Plate XV. figs. 1 *a* & 2; XII. figs. 5–7). This last form is the most frequent, and is to be considered as the typical. These leaves are of a pretty hard texture, but they seem to have been less leathery than those of *Q. furvinervis.* There are no entire leaves preserved; however, with the aid of the different pieces we can complete one. They were broadest in the middle, and gradually tapered towards the petiole and apex. In most of the fragments the petiole is not preserved. The piece represented in Plate

XII. fig. 9 shows us a petiole 14 millims. in length, in which it differs from *Q. furvinervis.* The pieces represented in Plate XVII. figs. 4 & 5 show us that the apex of the leaf was very long. The piece represented in fig. 5 had a very tapered apex. The broad leaves have a pretty strongly undulated margin (Plates XIII. fig. 1 *a*, and XII. fig. 7, magnified 7 *b*) without forming teeth. The median nerve is strong and straight. Numerous secondary nerves spring from it at an angle of 50°. They are rather strongly curved, and reach nearly to the margin, where they fork, and the upper branch bends forward and, running parallel with the margin to the next following secondary nerve, joins it. The lower branch of the fork is very small and slender, or quite wanting in slightly undulated leaves, and at the places where the undulation is wanting. This course of the secondary nerves is very characteristic of our species, as of *Q. furvinervis* and *Q. undulata.* The areas are divided into secondary areas by continuous, sometimes forking nervules. A polygonal reticulation may be perceived in them, which encloses a still more delicate one (cf. Plate XII. fig. 7 *b*).

Rossmässler has described two forms of leaves from Altsattel as *Phyllites furvinervis* and *Ph. cuspidatus.* The latter differs from the former in the undulated margin (which is not toothed), and the long tapering point. As I also got from Weissenfels the toothed form with an elongated point, I formerly united *Ph. cuspidatus* with *Ph. furvinervis* (cf. Beiträge zur nähern Kenntniss der sächsisch-thüring. Braunkohlen-flora, von O. Heer; Abhandlungen des naturw. Vereins für die Provinz Sachsen und Thüringen, ii. p. 424), and I described the form with the narrow leaves as *Q. furvinervis cuspidata.* But as at Bovey there is found only the form with the undulated leaves, and as there is a petiole (which is not preserved with the leaves of Altsattel) which by its length gives us a new distinctive character for *Phyllites cuspidatus*, I have separated it from *Ph. furvinervis.* The name given by Rossmässler could not be retained, as there is already a *Quercus cuspidata*, Thunb. The principal distinction between *Q. Lyelli* and *Q. furvinervis* consists in the length of the petiole, and in the latter species having undulated leaves.

Further examination, and a comparison of more copious material, will show if these differences are specific or not. They belong, at all events, to the same type, which was very frequent in the Lower Miocene period, and of which similar species are still living in Mexico (for instance, *Q. xalapensis*, Thunb.). *Quercus undulata*, O. Weber* (Palæontograph. ii. p. 170, pl. 19. figs. 1, 2 *a* & *b*), is also a very similar species. In the undulated margin, and the manner in which the secondary nerves run, it is like *Q. Lyelli*; but the median nerve of this species is straight and much stronger, not undulated; the secondary nerves are more numerous, and spring at less acute angles.

I still doubt if the leaf represented in Plate XII. fig. 7 belongs to the species in question. The form and kind of tapering at the base agree, but it has more numerous and more crowded secondary nerves.

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* The leaves (pl. 19. fig. 2 *a* & *b*) in Weber's 'Abhandlung' belong, according to my opinion, also to *Quercus undulata*, and are different from *Q. Gœpperti* (pl. 19. fig. 2 *c*), in which the leaf is rounded at the base. I may mention that the leaf which Ludwig (Palæontogr. viii. pl. 34. figs. 1–4) has represented as *Q. furvinervis*, belongs to another species.

I found in the 26th bed at Bovey several fragments of bark which probably belonged to an oak, and therefore might belong to the species in question. The bark is very thick and corky, provided with deep longitudinal furrows, and in some places furrowed transversely (cf. Plate XVII. fig. 6).

Fam. II. MOREÆ, Endl.

2. FICUS, Tournef.

I have already mentioned in my 'Flora Tertiaria' (ii. p. 64) that the leaves of many living species of fig-trees (I allude to the species which have leaves similarly shaped to *Ficus fulva*, Spr., *F. rubra*, Spach, *F. ferruginea*, Desf., and *F. phytolaccæfolia*, Hort. Berol.) have a granulated appearance and a rough surface due to numerous little warts which cover the epidermis, and that the tertiary flora of Switzerland also possessed two species, the leaves of which had the same rough surface. It is very curious that there are in the 26th bed at Bovey leaves which are granulated in this manner; and one of them is very near to *Ficus scabriuscula*, Hr. I therefore believe that I am not mistaken in ranging these three species under the genus *Ficus*. The following facts indicate that the granulation belongs to the leaf and not to the stone:—1. The stone certainly is finely granulated; but these granules are larger than the small points of the leaves, which can only be seen with the aid of a lens, and which are all of the same size; 2. they are regularly spread over the surface of the leaf; 3. they are on all the pieces of this species, but not on the leaves of other plants (e. g. *Cinnamomum lanceolatum*, *Daphnogene Ungeri*, and *Lastræa Bunburii*), which are lying in the same clay.

14. FICUS FALCONERI, m. (Plates XII. fig. 1 *a*; XIII. figs. 6 & 7; XV. fig. 4.)

F. foliis coriaceis, magnis, confertissime granulatis, elliptico-lanceolatis, apice longe acuminatis, nervis secundariis subtilissimis, remotis, valde curvatis.

The leaf represented in Plate XIII. fig. 7 is the best preserved. The upper part is quite perfect, but the base is wanting. It is entire, and 12 millims. wide in the middle; it is gradually tapered towards the apex, forming a long narrow point. The secondary nerves are very delicate, and there are but few to be discovered with the lens. They are strongly curved, and form arches, which are far from the margin. The areas are divided by very delicate nervules, and filled up with a very delicate reticulation. The rigid points which cover the whole surface are very small, and only to be seen with a strong lens. Plate XIII. fig. 6 is the point of the leaf, the secondary nerves of which are more distinct.

It is still doubtful if the leaf represented in Plate XII. fig. 1 *a* belongs to this species. It shows the same peculiar sculpture (cf. fig. 1 *a a*), and also very delicate secondary nerves; but they approach nearer to the margin, and are much less directed towards the apex. This leaf is very like *Ficus obtusata*, Heer*, and belongs perhaps rather to this species; but as the specimen is incomplete, it is better to unite it with *Ficus Falconeri*. It may be that the areoles of the small areas are not so long (cf. fig. 1 *a a* magnified, and 1 *a a a* still more magnified) as those of *Ficus obtusata*. They are quite covered with little warts. The secondary nerves of the leaf in question are also very delicate, and united in strongly curved arches at the end. The areas are divided by means of delicate nervules into secondary areas, in which is the fine polygonal reticulation (fig. 1 *a a*).

15. FICUS PENGELLII, m. (Plates XIV. figs. 7 & 8, and XV. fig. 3.)

F. foliis coriaceis, longe petiolatis, confertissime granulatis, ellipticis, basi apiceque attenuatis, nervis secundariis remotis, angulo acuto egredientibus, valde curvatis.

The leaf represented in fig. 8 shows the same peculiar sculpture as the former species (cf. fig. 8 *b*, where the portion of a leaf is magnified); it is more indistinct in the second leaf (fig. 7), which belongs to the same species. The species in question differs from the former one in the elliptical form of the leaf, which has no long point, and the acute angle of the secondary nerves. The leaf is broadest in the middle and equally tapered at both ends, so that the sides form pretty regular curved lines. The secondary nerves are delicate, springing from acute angles, strongly bent towards the apex, and thus form long arches. The principal areas are divided by means of delicate nervules into secondary areas, in which the polygonal areas are covered with very small rigid points that are only to be seen with the aid of a strong lens. The petiole is very long, and rather slender. It belongs to the same section as *Ficus phytolaccæfolia*, Hort. Berol.

16. FICUS EUCALYPTOIDES, m. (Plate XIV. figs. 3, 4 & 5.)

F. foliis coriaceis, lanceolatis, confertissime granulatis, basi apiceque attenuatis, nervis secundariis subtilissimis, valde curvatis.

This is another hard leathery shining leaf, but much smaller than that of the former species. It is broadest in the middle, and almost equally tapered towards both ends. It is doubtful if a petiole existed. Very delicate secondary nerves spring from the median nerve; they are jointed in strong arches. The surface is also covered with very delicate warts. It is like the leaf of *Eucalyptus oceanica*, Ung., in form, but differs especially in the surface, because *Eucalyptus* has quite a smooth leaf.

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* Flora Tertiaria, ii. p. 65, pl. 82. figs. 5 & 6, pl. 100. fig. 14.

Order II. PROTEINÆ.

Fam. I. LAURINEÆ, Vent.

1. LAURUS, Linn.

17. LAURUS PRIMIGENIA, Ung. (Plate XIV. fig. 6.)

L. foliis subcoriaceis, late lanceolatis, acuminatis, nervo primario valido, nervis secundariis tenuibus, sparsis, sub angulo acuto egredientibus.

Unger, Fossile Flora von Sotzka, p. 38, pl. 19. figs. 1–4.

Heer, Flora Tertiaria Helvetiæ, ii. p. 77, pl. 89. fig. 15; iii. p. 184, pl. 153. fig. 3.

In the 26th bed.

The leaf represented in Plate XIV. fig. 6 agrees very well with the leaf of the Hohe Rhonen, which is represented in pl. 153 in my 'Flora.' It is dark brown, rather hard, smooth and entire, and gradually tapered towards the base. The secondary nerves are at a distance from each other, strongly curved, and form long arches near the margin. The large principal areas are divided into secondary areas by fine nervules. The apex of the leaf is not preserved.

2. CINNAMOMUM, Burm.

18. CINNAMOMUM ROSSMÄSSLERI. (Plate XVI. figs. 17 & 18.)

C. foliis ellipticis vel oblongo-ellipticis, triplinerviis, nervis lateralibus acrodromis apicem attingentibus, nervatione in areis reticulata.

Flora Tertiaria Helvetiæ, ii. p. 84, pl. 93. figs. 15–17.

Phyllites cinnamomum, Rossmässler, Versteinerungen von Altsattel, p. 23, taf. 1. fig. 4.

Daphnogene cinnamomifolia, Unger, Genera et Spec. Plant. Foss. p. 424.

Bovey Tracey, in the 17th bed.

The two fragments figured are the only ones which were found; their apices are wanting, the determination therefore cannot be considered as quite sure. The leaf, however, agrees in its size, form, and nervation with *C. Rossmässleri.* Only a little piece is wanting in the leaf represented in fig. 18, as the raised sides show; the two lateral nerves run, however, to the end of the preserved part, and are so distinct there that undoubtedly they reached to the apex, which forms the principal character of the leaf, which is nearly related to *C. zeylanicum*, Bl., and still more to *C. eucalyptoides*, Nees (*C. nitidum*, Hook.). The leaf has a tolerably slender petiole; it is broadest in the middle, and equally tapered towards both ends. The two lateral nerves springing above the base are pretty strong, and run parallel with the margin. The very delicate nervules spring at right or at least not very acute angles.

19. **Cinnamomum Scheuchzeri.** (Plates XVI. figs. 9–16; IV. fig. 4 *e*; XVII. fig. 12.)

C. foliis petiolatis, ellipticis, ovalibus et oblongis, triplinerviis, nervis lateralibus margine parallelis vel subparallelis, apicem non attingentibus; pedunculis articulatis, pedicellis apice incrassatis, fructibus ovatis.

Flora Tertiaria Helvetiæ, ii. p. 85, pl. 91. figs. 4–24, pl. 92, pl. 93. figs. 1–5.

Rather frequent in the 17th and 26th beds at Bovey.

These are leathery, entire, and three-nerved leaves, which are broadest in the middle, and gradually and equally tapered towards both ends; they are acuminated at the base in the same manner as at the apex, without running into the petiole; the sides form almost regularly curved lines. The two strong lateral nerves are jointed above the base of the leaf; they are mostly opposite (Plate XVI. figs. 11, 13 & 16), the one seldom a little higher than the other (Plate XVI. figs. 10 & 15); they run parallel with the margin. They do not reach to the apex of the leaf, but they unite above the middle of the leaf with a secondary nerve of the midrib (figs. 10 & 11). The areas are provided with very delicate nervules, which spring at almost right angles. I found the two flowers which are represented in Plate XVII. figs. 13 & 13 *c* (magnified 13 *b* and 13 *d*) in the 26th bed of Bovey. They very much resemble the flower from Oeningen represented in the 'Flora Tertiaria Helvetiæ,' pl. 91. fig. 23 *b*, and therefore probably belong to *Cinnamomum Scheuchzeri*. The leaflets of the perianthium of the flower represented in fig. 13 *c* are indistinct; they are much better preserved in fig. 13 (magnified 13 *b*). There are six leaflets, standing in two whorls around a circular wall. The leaflets are hard, shortly oval, obtusely rounded at the apex, and provided with longitudinal striæ. They are shorter and broader, and more obtusely rounded than in *Cinnamomum polymorphum*, A. Br. (cf. Flora Tertiaria Helvetiæ, pl. 94. figs. 1–5). We have beautiful branches from Oeningen with leaves of this species. We lately got a branch with the inflorescence, which confirms the systematic position which I assigned to the leaves. I therefore represent this branch in Plate XVI. fig. 12. Numerous flowers, still in the state of buds, but nearly breaking off, are lying together, and sometimes one above the other, so that it is not possible to find out their insertion with certainty. One sees, however, that the peduncles spring from the axils of the leaves, and we have therefore an axillary inflorescence. The peduncles are club-shaped above, and this part forms with the bud an almost globose body, on which the leaflets of the perianthium are indicated at some places. These peduncles lengthen afterwards and become more sharply articulated, as the peduncles and fruit-stalks which I have represented in my 'Flora Tertiaria' (pl. 91. figs. 4–7) show.

It is very like *C. pedunculatum*, Thb., from Japan.

20. **Cinnamomum lanceolatum.** (Plates XVI. figs. 1–8; XVII. figs. 14 & 15.)

C. foliis petiolatis, lanceolatis, basi apiceque acuminatis, triplinerviis, nervis lateralibus margine parallelis, approximatis, acrodromis, apicem non attingentibus.

Flora Tertiaria Helvetiæ, ii. p. 86, pl. 93. figs. 6–11.

Daphnogene lanceolata, Unger, Fossile Flora von Sotzka, p. 37.

Rather common in the 17th and 26th beds; it is also a leaf of the 54th bed.

Is like *C. Scheuchzeri*, but differs from it in the leaves being narrower, longer, elongated into a long point, and tapering towards the petiole.

The leaf is also leathery, strongly tapered towards the base, and gradually towards the apex, forming a long sharp point. The two strong lateral nerves are near the margin and run parallel with it; delicate secondary nerves proceed from the median nerve above the middle of the leaf and join them; several delicate secondary nerves follow more outwards. The areas are traversed with very fine nervules, and the secondary areas which these form are filled up with a fine polygonal reticulation. The nervules spring at almost right angles, and the upper secondary nerves at acute angles. Fig. 1 represents a leaf of the 26th bed, the others are of the 17th; figs. 5 & 6 represent young leaves.

3. DAPHNOGENE, Ung.

21. DAPHNOGENE UNGERI, Hr. (Plate XIV. figs. 1 & 2.)

D. foliis lanceolatis, basi subrotundatis, longe petiolatis, triplinerviis, nervis basilaribus margine subparallelis, nervulis obsoletis.

Flora Tertiaria Helvetiæ, ii. p. 92, pl. 96. figs. 9–13.

Ceanothus lanceolatus, Ung., Fossile Flora von Sotzka, p. 49.

Bovey, in the 26th bed.

This leaf differs from those of *Cinnamomum Scheuchzeri* and *C. lanceolatum* in being widest below the middle, and in the delicate nervules being absent in the large areas. In most of the leaves of this species from our molasse, and also from Manosque in Provence, the base of the leaf is rounded, which is not the case in the Bovey leaves; but since also at Sotzka (cf. Unger, plate 31. fig. 14) leaves occur of which the base is not so much rounded off, we may without hesitation unite the Bovey leaves with the above-mentioned species. The leaf (fig. 2) otherwise agrees very well with that which is represented by UNGER.

The leaves are hard, coriaceous; they attain the greatest breadth below the middle, and taper gradually to the apex. The strong lateral nerves run near the margin and parallel with it; they have no visible nervules in the areas.

Fam. II. PROTEACEÆ, R. Br.

4. DRYANDROIDES, Ung.

22. DRYANDROIDES HAKEÆFOLIA, Ung. (Plate XIV. fig. 12 *a.*)

Dr. foliis coriaceis, firmis, lanceolatis lineari-lanceolatisque, in petiolum attenuatis, apice acuminatis, plerumque apice dentatis, dentibus remotis, inæqualibus, nervo medio valido, nervis secundariis subtilissimis, camptodromis, areis marginem fere attingentibus, nervatura firma, hypodroma, areolis magnis scrobiculatis.

Unger, Fossile Flora von Sotzka, p. 39, pl. 20. figs. 7–10.

Heer, Flora Tertiaria Helvetiæ, ii. p. 100, pl. 98. figs. 1–13, plate 99. figs. 4–8.

Only fragmentary leaves have been found at Bovey (in the 17th bed), but they cannot be mistaken, since they have the characteristic nervation of this species. In one piece (which in fig. 12 *a* lies upon the slab with the apex pointing downwards) part of the margin is still complete, and shows the sharply indented teeth which *Dr. hakeæfolia* commonly has. In the same leaf the nervation is pretty well preserved. The secondary nerves are very delicate, and project but very little beyond the other reticulation. To the naked eye, or when but slightly magnified, the leaf appears dotted, owing to the distinctly projecting small arches which form the reticulation.

23. DRYANDROIDES LÆVIGATA. (Plate XIV. figs. 9, 10 & 11.)

Dr. foliis coriaceis, firmis, lanceolatis, basi in petiolum attenuatis, apice attenuatis plerumque integerrimis, nervo medio valido, nervis secundariis manifestis camptodromis.

Flora Tertiaria Helvetiæ, p. 101, pl. 99. figs. 5–8.

In the 17th bed of Bovey.

It is very like the preceding species; but the margin is generally entire, and the nervation is more delicate, being less prominent.

The leaf of Bovey which has been represented in fig. 10 is coriaceous, lanceolate, and tapering gradually towards the tip, where it ends in a point; it is entire; the median nerve is rather strong, but the secondary nerves are very delicate; they reach to near the margin, where they form arches. The more delicate reticulation, which is formed by very small and densely crowded areoles, can be made out by the aid of a lens, but it is much less distinct than in the foregoing species.

The leaf agrees well with that which has been represented in plate 99. fig. 7 of my 'Flora Tertiaria.'

24. DRYANDROIDES BANKSIÆFOLIA. (Plate XVII. fig. 7.)

Dr. foliis petiolatis, firmis, linearibus vel lanceolato-linearibus, undique argute serratis, basi apiceque acuminatis, nervis secundariis approximatis, subrectis, simplicibus, parallelis.

Flora Tertiaria Helvetiæ, ii. p. 102.

Myrica Banksiæfolia, Ung., Gen. et Spec. Pl. Fossil. p. 395.

Bovey, in the 26th bed.

Only the portion of a leaf represented in Plate XVII. fig. 7 has been found at Bovey. It cannot be determined with certainty, as the characters which the above diagnosis (copied from my 'Flora') contains are not recognizable in them.

It was certainly a hard leathery leaf with a very delicate nervation. The secondary nerves are but slightly indicated and run towards the teeth, which are very sharply cut. The fragment probably represents part of the leaf near the base, like plate 100. fig. 10

of the 'Flora Tertiaria Helvetiæ'; and that is the reason why the teeth are there wanting. We find them, however, in most of the leaves of *D. Banksiæfolia.*

Fam. III. SANTALACEÆ, R. Br.

5. NYSSA, Linn.

25. NYSSA EUROPÆA, Ung. (Plate XVIII. figs. 11–17.)

N. putamine 4½–7 mm. longo, 3–6½ mm. lato, ovali, rarius subgloboso, basi truncato, extus striis longitudinalibus rugosis exarato.

Unger, Sylloge Plantar. Fossil. p. 16, pl. 7. figs. 25–27.

Frequent in the 26th bed of Bovey.

The fruit most probably agrees with the fragments which UNGER described as found at Nidda in the Wetterau, and which I got from Salzhausen; the latter are, however, somewhat more compressed, and consequently more flattened; hence the wrinkled longitudinal ribs do not project so much. Very similar also is a fruit represented as *Nyssa rugosa* by O. WEBER in the 'Palæontographia,' ii. plate 20. fig. 10 *c*; this fruit differs, however, in its shape and smaller dimensions, from two other fruits that were mentioned by WEBER under the same name.

We distinguish amongst the Bovey fruits three forms:—

a. Oval fruits, 4½ to 5½ millims. long and 3 to 4 millims. wide; they are truncated at the base, in the fore part obtusely rounded and marked with numerous rather deeply wrinkled longitudinal furrows (figs. 11–14, magnified 12 *b*).

b. Oval fruits, 6–7 millims. long and 4–5 millims. wide; they are also truncated at the base, but somewhat rounded, marked with numerous wrinkled longitudinal furrows. They are shaped like the stones of *Nyssa sylvatica*, but are somewhat smaller (figs. 15 & 16).

c. Nearly globose fruits, 7 millims. long and 6 to 6½ millims. wide; at the base abruptly truncate, with strongly marked irregular wrinkled furrows (fig. 17, magnified 17 *b*).

The form *a* is the most frequent; the form *c* has been met with in but a few pieces; the form *b* is not rare, and corresponds most to the fruit-stones of the Wetterau. Whether these forms belong to one or more species, I dare not decide.

They are very like the fruit-stones of the species of *Nyssa* which grow at present in the United States, especially of *Nyssa biflora* and *denticulata*, which are represented by GÄRTNER (De Fructibus, iii. p. 216).

26. NYSSA LÆVIGATA, m. (Plate XVIII. fig. 18, magnified 18 *b*).

N. putamine 5–7 mm. longo, 4–5 mm. lato, ovali, basi truncato, lævigato, extus bistriato.

In the same bed of Bovey; rare.

It has the same dimensions and shape as the foregoing species, but it is smooth, shining, and without wrinkled furrows, notwithstanding we observe on the outside two longitudinal lines, which are formed, as in the fruit-stones of *Nyssa*, by delicate striæ.

27. **Nyssa microsperma**, m. (Plate XVIII. fig. 24, magnified 24 *b.*)

N. putamine 4 mm. longo, globoso, extus striis longitudinalibus rugosis exarato.

Only a single specimen from the same bed.

It is upon the whole very like the small forms of *Nyssa europæa*, but it is still smaller, perfectly globose, truncated at the base and deeply furrowed.

At the base of the fruit-stone appears a small hole; the sides are marked with deep longitudinal furrows, and the intervening ribs are wrinkled.

28. *Nyssa striolata*, m. (Plate XVIII. figs. 20–23, magnified 20 *b.*)

N. putamine 10–12 mm. longo, 6–8 mm. lato, compresso, ovali, tenuiter longitudinaliter striato.

Several specimens from the 26th bed.

It is very like the *Nyssa ornithobroma*, Ung. It is of the same shape and the same dimensions as the specimen represented by Unger (fig. 16), from which we must separate it, because the striæ are more delicate and more densely arranged. The small nuts are perfectly flattened, and at the base obtusely rounded, but they terminate in the apex in a small point. Along the middle of each specimen runs a longitudinal fissure, which was probably caused by pressure. The side is furrowed by numerous very delicate longitudinal striæ, while the intervening spaces are smooth.

Coh. II. *GAMOPETALÆ.*

Order I. BICORNES, Endl.

Fam. I. Ericaceæ, Dec.

1. Andromeda, Linn.

29. **Andromeda vacciniifolia**, Ung. (Plate XVII. fig. 9.)

A. foliis coriaceis, oblongis, integerrimis, apice obtusis, basi rotundatis vel subrotundatis, petiolatis.

Unger, Fossile Flora von Sotzka, p. 43, pl. 23. figs. 10–12.

Heer, Flora Tertiaria Helvetiæ, iii. p. 7, pl. 101. fig. 25.

In the 17th and 26th beds of Bovey.

I found several pieces, but only the one represented in fig. 6 has remained entire, the others have been ruined on the journey. This leaf certainly agrees with the leaves represented in my 'Flora,' figs. 25 *b* and 25 *c*. The leaf has a petiole and a pretty strong median nerve; the lateral nerves are obsolete, and the reticulation is not preserved.

30. **Andromeda reticulata**, Ett. (Plate XVII. figs. 10 & 11.)

A. foliis coriaceis, lineari-lanceolatis, acuminatis, basi in petiolum attenuatis, integerrimis, nervatione dictyodroma.

Ettingshausen, Tertiäre Flora von Haering, p. 65, pl. 22. figs. 9 & 10.

Bovey; several pieces in the 26th bed.

The leaf is hard, leathery, and tapers towards the petiole, narrow-lanceolate, the sides almost parallel; the apex is not preserved in the leaves of Bovey. The median nerve is pretty strong; the whole leaf is covered with a fine polygonal reticulation (fig. 10 *b*, a portion of a leaf magnified), which reaches from the median nerve to the margin and has almost everywhere meshes of the same size. Only at some few places in this reticulation there appear delicate secondary nerves, which rise at a very acute angle. It very well agrees in the form and nervation with pl. 22. fig. 9 of ETTINGSHAUSEN'S work.

This species is nearly related to *Andromeda protogæa*, Ung., and is perhaps a variety of it; the reticulation is, however, much more delicate, and can only be seen with the lens. The leaf of *Eucalyptus oceanica*, Ung., is similarly shaped, but the nervation is different.

Fam. II. VACCINIEÆ, Dec.

2. VACCINIUM, Linn.

31. VACCINIUM ACHERONTICUM, Ung. (Plate XVII. fig. 8.)

V. foliis subcoriaceis, ovalibus vel oblongis, integerrimis, petiolatis.

Unger, Flora von Sotzka, p. 43 (ex parte), pl. 24. figs. 1, 3, 4 & 6.

Heer, Flora Tertiaria Helvetiæ, iii. p. 10, pl. 101. fig. 29.

Bovey, in the 26th bed.

A small longitudinal, oval and entire leaflet with a short petiole. The median nerve is thin, and several delicate curved secondary nerves proceed from it.

This leaflet is longer and more tapered at the base than those of the 'Flora Tertiaria Helvetiæ,' but it certainly agrees with the leaf represented by UNGER in the 'Flora of Sotzka,' pl. 26. fig. 6, and may therefore be referred to this species.

Order II. CONTORTÆ, Endl.

Fam. I. APOCYNEÆ, R. Br.

1. ECHITONIUM, Ung.

32. ECHITONIUM CUSPIDATUM, Hr. (Plate XIII. figs. 3 *b* & 5; Plate XIV. fig. 12 *c*.)

E. foliis lineari-lanceolatis, apice cuspidatis, integerrimis, nervis secundariis numerosis, camptodromis, areis margini approximatis, reticulatis.

Heer, Flora Tertiaria Helvetiæ, iii. p. 192, pl. 154, figs. 4–6.

Several pieces of leaves from the 17th bed of Bovey.

The more delicate nervation is almost obliterated in the fragments of the leaves from Bovey, but these agree well with our species as to their forms and the direction of the secondary nerves; nevertheless this determination cannot be considered to be quite certain. Very similar is a leaf from the lignite of the Rhine, which is represented by O. WEBER as *Labatia salicites* (Palæontogr. iv. p. 154, pl. 28. fig. 1); but the leaves of Bovey, like those of Locle, taper into a more elongated apex, and the arches of the secondary nerves approach nearer the margin, The leaf is very long and narrow, tapering gradually towards the base; and also elongating into a very long point. From the median nerve spring rather numerous secondary nerves, which are highly incurved, forming near the margin arches that run nearly parallel with the latter; these arches are very delicate, and can only be traced by the aid of a lens. The reticulation of the areas is only slightly indicated.

Order III. RUBIACINÆ.

Fam. I. RUBIACEÆ, Juss.

1. GARDENIA, Ell.

33. **GARDENIA WETZLERI**, Hr. (Plate XVIII. figs. 1–8.)

G. fructibus lignosis, oblongo-ovalibus vel ovato-lanceolatis, subcostatis et multistriatis, polyspermis, seminibus nigro-brunneis, nitidis, striis spiralibus notatis.

Heer, Flora Tertiaria Helvetiæ, iii. p. 192, pl. 141. figs. 81–103.

Passiflora Braunii, Ludwig, Palæontograph. viii. p. 124, pl. 48. figs. 1, 4, 5 & 16.

Bovey Tracey, in the 34th bed.

At Bovey no complete fruits have been found like those which we know from near Königsberg, from the brown-coal of the Rhön and Wetterau and of Günzburg, but we have got rather numerous seeds, partly still in the position which they held within the fruits (cf. Plate XVIII. figs. 1 & 2). These seeds agree, in respect to their position, their forms, and the peculiar structure of the testa, so entirely with those of the Continent, that no doubt can arise about the question whether they belong to the same plant or not. They are arranged in series, but in such a manner that they partly overlie each other; and in consequence of pressure the shape has been here and there somewhat altered, resulting in more or less deep impressions. Figures 3–5 (magnified) show the principal forms which the seeds of Bovey display. At the apex they taper into a small point, at the base they are somewhat rounded; the colour is a shining brownish black, furrowed by very delicate striæ forming distinct spirals, the deeper striæ alternating with the more delicate (cf. especially the highly magnified piece of a seed, fig. 6).

In order to illustrate this remarkable species, which has such a very wide range, I have represented in fig. 7 a fine fruit that was sent me by Director ALBRECHT of Königsberg out of the clays of Samland; fig. 8 represents a similar fruit from Günzburg, remarkable for its great dimensions.

In the 'Flora' (*l. c.*) I have described this species at full length, and I have tried to show that it belongs to the genus *Gardenia*, while LUDWIG refers it to *Passiflora*. It cannot belong to the latter genus, since *Passiflora* has fleshy fruits on long slender stalks, and seeds which are always distinguished by peculiar little pits ("semina impresso-scrobiculata" is mentioned by ENDLICHER as a characteristic feature of this family). Even the genus *Vareca*, to which LUDWIG refers, has fleshy hexagonal fruits, which are only about half an inch long, and furnished at the base with a small round cup with six notches; of the seeds each rests in a separate cell: all these are peculiarities which are not met with in the fossil fruit (cf. Gärtner, De Fructib. et Seminib. i. p. 290).

In the 'Flora' I have enlarged upon the reasons why I united these fruits and seeds with *Gardenia.* The *Gardenia lutea*, Fres. and *G. Thunbergii*, L. fil., have also ligneous fruits with a pericarp furrowed by similar longitudinal fibres, and they are also supported on short and thick stalks that pass gradually into the fruit; besides we remark, exactly in the same manner as in the fossil fruit of Königsberg, represented in fig. 7 *b*, the placentæ parietales forming ridges, which project from the inner surface, and which constituted most probably soft membranaceous partitions proceeding towards the interior. The seeds of some Gardenias are arranged in series of which the number varies—in one fruit, known from the Brazils, in four, in others in more series; the number of the placentæ also varies from two to six. Thus we have in *G. Thunbergii* five, in *G. lutea* six, while the seeds lie together in great numbers and are indistinctly arranged in series; they are horizontal; in the fossil fruit they are also horizontal, but generally somewhat obliquely turned towards the bottom, with the point directed towards the base of the fruit. They are arranged in series, which are, however, but very seldom as distinctly marked as is the case in the pieces represented by Ludwig. I thought I could distinguish five series, but Ludwig mentioned six; and if so, we should in these fruits assume three placentæ, to each of which two series of seeds are fixed. Yet in the fruit from Königsberg there seem to exist four placentæ; two are visible in the interior of the one-half of the fruit of which the outside is represented in fig. 7 *b*, and two seem to be on the other half (7 *a*); one, which is very distinct, runs somewhat beyond the middle throughout the fruit, and another seems to have existed on the right side at the edge; this latter, however, is indistinct and uncertain. In fig. 7 *c* I have represented the transverse section; the line marks the place where the fruit was broken into halves: also from Salzhausen I got only fruits which were thus split in the middle into halves. I do not know upon what grounds M. Ludwig supposed that the fruit was divided into three valves. It was certainly an indehiscent fruit.

Coh. III. *POLYPETALÆ.*

Order I. UMBELLIFLORÆ.

Fam. Ampelideæ, Kunth.

1. Vitis, Linn.

34. **Vitis Hookeri.** (Plate XVIII. figs. 27, 28 & 29.)

V. seminibus parvis, 3½ mm. longis, 3 mm. latis, brevibus, ovato-acuminatis, læviusculis, dorso convexiusculis, tuberculo chalazino rotundato magno.

Bovey Tracey, in the clay of the 26th bed.

I have got but one single seed of this species, which, however, cannot be mistaken. It is very like those of the grape of Salzhausen, which A. Braun described as *Vitis* *teutonica*, and of which Unger (Syllog. Plantarum, p. 23, pl. 9. figs. 1–8) and Ludwig (Palæontogr. viii. p. 118, pl. 45. figs. 1–5, pl. 46. fig. 6) lately gave descriptions and drawings; it is a species which had a very wide range, and which I pointed out as occurring at Oeningen, in the brown coals of the Rhön and at Schossnitz. The seed of the grape of Bovey is, however, smoother, comparatively wider and shorter; more flattened on the dorsal part, and the little pits on the ventral surface are less deep; while also the small wart (verruca) on the back is somewhat larger, for which reasons we must separate the seed of this grape as a different species.

It is most obtusely rounded at the base, and terminates at the apex in a little short point; upon the dorsal part (fig. 29, six times magnified fig. 29 *d*) it is only slightly convex; the chalazal tubercle (tuberculum chalazinum) is large and nearly circular; upon the ventral part (fig. 29 *b*, *c*) appears a rather prominent ridge, along the middle of which runs, as in *Vitis teutonica*, a delicate longitudinal stria; on each side of the ridge we observe a small pit (scrobicula), which, however, is much less deep than in *Vitis teutonica.*

To this or the following species belong probably the grapes from the 17th bed of Bovey (figs. 27 & 28), which are very like those of *Vitis teutonica.* They are flattened, nearly circular fruits, in the interior of which no grains can be distinguished, as in those from the brown coals of Langenaubach (cf. Ludwig, *l. c.* p. 120).

Fig. 29 represents the dorsal surface of the seed; fig. 29 *b*, the ventral surface; fig. 29 *c*, *d*, magnified; fig. 29 *c*, section; figs. 27 & 28, grape.

35. *Vitis britannica*, m. (Plate XVIII. figs. 25 & 26.)

V. seminibus parvulis, 5½ mm. longis, 3 mm. latis, ovato-ellipticis, dorso planis, tuberculo chalazino obsoleto.

From the 26th bed of Bovey.

Of this species I got two seeds, which belong probably to *Vitis* or *Cissus*; but the chalazal tubercle is not distinct, and the consequent determination cannot be considered to be quite certain. These seeds are longer and comparatively narrower than those of the foregoing species; on the ventral side we observe the prominent ridge; the pits on both sides are very flat and oblong; the dorsal part is flattened. On one seed (the other is much compressed) we observe an oval tuberculum chalazinum, which appears, however, flat, imperfectly stamped out, and therefore indistinct.

Order II. POLYCARPICÆ, Endl.

Fam. Anonaceæ, Dun.

1. Anona, Linn.

36. Anona (?) devonica, m. (Plate XIX. figs. 1–3.)

A. seminibus ovalibus, 19–21 mm. longis, 12–14¼ mm. latis, compressis, læviusculis.

A good many specimens from the 26th bed of Bovey.

Belongs probably to *Anona altenburgensis*, Ung. (Sylloge Plantar. p. 26, pl. 10. figs. 8–11). The representation agrees pretty well with the seeds of Bovey; but as Unger in the diagnosis calls the seeds "ovato-oblongis," and since those of Bovey are no wider at the base than at the top, I dare not to unite them with those of Altenburg.

Most of the specimens are 20 to 21 millims. long, widest in the middle, narrowing symmetrically towards both ends, where they are most obtusely rounded. They are flat, the diameter only amounting to 2½ millims.; throughout they are formed of an homogeneous mass of coal, which has obliterated all traces of the contents of the seeds. On the outside they are smooth and rather shining when rubbed; sometimes they appear reticulated by delicate fissures, or furrowed with very fine longitudinal and transverse striæ, which are, however, much obliterated, and can only be perceived by the aid of a lens. In some pieces the middle portion is perfectly flat and slopes towards a rather sharp margin (cf. section, fig. 2 *b*), thus forming a flatly bordered seed like those of *A. paludosa*, Ait.; in others the margin is blunted. In one piece (fig. 3) the middle portion has fallen out, thus producing a broad and deep furrow; this is probably only accidental.

In fig. 1 the seed still lies within the stone, convincing us that it is not surrounded by a shell. The perfectly homogeneous substance of the coal indicates a seed and not a fruit; and since the Anonas (especially the *A. paludosa* and *Asimina triloba*) have quite similar seeds, I agree with the determination of Unger, although it cannot be denied that it must be considered as somewhat doubtful till other organs shall be discovered.

37. Anona cyclosperma, m. (Plate XIX. fig. 4.)

A. seminibus suborbiculatis, 14 mm. longis, 11–12 mm. latis, compressis, rugulosis.

At the same spot; several specimens.

They are very like the preceding, but much smaller, especially much shorter; and as the breadth is nearly the same, they are almost orbicular; a network is constituted by numerous irregular fissures, which cause the outside to be somewhat wrinkled (fig. 4 *b*). Since no intermediate forms occur between this and the foregoing, they seem to belong to different species.

Order III. HYDROPELTIDEÆ.

Fam. Nymphæaceæ, Salisb.

1. Nymphæa, Linn.

38. Nymphæa Doris, m. (Plate XIX. figs. 32–37.)

N. seminibus ovalibus, 2½–3½ mm. longis, subtilissime crenulato-striolatis, apice poro perforatis.

From the 54th bed.

Tolerably numerous flattened seeds lying close together: they are oval, 2½ to 3½ millims.

long and 2 to 3 millims. wide; at both ends they are obtusely rounded, and at one end are furnished with a small round hole (fig. 33, magnified fig. 34; fig. 35, magnified fig. 36), which is only visible in those specimens that are compressed from above. The sides are furrowed by very delicate and elegant longitudinal striæ, formed by the cells, which are arranged in lines. They are neatly crenated and very delicately dotted (cf. fig. 37, a highly magnified piece, of which only part of the testa has been preserved). This elegant sculpture can only be made out by the aid of a lens or microscope.

They are very much like the seeds of *Nymphœa alba*, especially the form with the larger seeds, the *Nymphœa alba melocarpa*, Casp. In the recent seeds the longitudinal striæ appear much less distinct; but in such seeds as are found in the 'Pfahlbauten' of ROBENHAUSEN, they look exactly like those of the fossil species. In these also the hole on the top of the seed is somewhat more widened, as in the fossil species. As to the shape, the latter differs in so far as the seeds are comparatively somewhat wider (those of *N. alba melocarpa* are 3½ millims. long and 2 millims. wide): this more considerable breadth may have been caused by pressure, since they are all highly compressed. To the same circumstance we may ascribe the fact that the raphe cannot be pointed out distinctly.

The seeds of Bovey are very like those of my *Nymphœa Charpentieri* (Flora Tertiaria, iii. p. 195, pl. 155. fig. 20 *b*, *c*), the latter being only somewhat narrower. It would therefore be very desirable that the leaves be sought for at Bovey, since from these alone can it be decided with certainty whether this species is really distinct from *N. Charpentieri*, to which it comes very near. The seeds of the living *Nymphœæ* are variable in their dimensions.

Order IV. MYRTIFLORÆ.

Fam. MYRTACEÆ, R. Br.

1. EUCALYPTUS, Hérit.

39. EUCALYPTUS OCEANICA, Ung.? (Plate XVIII. figs. 9 & 10.)

E. foliis coriaceis, 2–5-pollicaribus, lanceolatis vel lineari-lanceolatis, acuminatis, subfalcatis, in petiolum attenuatis, integerrimis, petiolis semipollicaribus, sæpius contortis, nervo primario distincto, secundariis subtilissimis.

Unger, Flora von Sotzka, p. 58, pl. 36. figs. 1–13.

Heer, Flora Tertiaria Helvetiæ, iii. p. 34, pl. 108. fig 21, pl. 154. figs. 14 & 15.

In the clay of the 26th bed.

As at Bovey only fragments of leaves have been found, no sure determination can be given. The leaves are smooth, shining, coriaceous, somewhat incurved, and taper towards the tip. The secondary nerves are very delicate and form arches, which run nearly parallel with the margin. Close by the leaf (represented in fig. 9) lies the top of a leaf of a quite different plant, which seems to belong to *Quercus Lyelli*.

2. Eugenia, Mich.

40. **Eugenia Hæringiana**, Ung. (Plate XVII. figs. 16, 17 & 18.)

E. foliis coriaceis, lanceolato-linearibus, in petiolum brevem crassumque attenuatis, integerrimis, nervis secundariis distantibus, simplicissimis, camptodromis, duobus inferioribus valde elongatis.

Unger, Flora von Sotzka, p. 52, pl. 35. fig. 19.

Heer, Flora Tertiaria Helvetiæ, p. 34, pl. 2. fig. 1, pl. 108. fig. 16, pl. 154. fig. 13.

Bovey, in the 26th bed.

The leaves of Bovey are very like the leaf of Ralligen represented in my 'Flora,' pl. 108. fig. 16. They are leathery, entire, long and narrow, and tapered towards the petiole, the sides being almost parallel. The two long secondary nerves are very near the margin, and run nearly parallel with it. We cannot distinguish the finer nervation.

Resembles *Cinnamomum lanceolatum*, but the leaf is longer, relatively narrower, and has parallel sides.

Order V. FRANGULACEÆ.

Fam. Celastrineæ, R. Br.

1. Celastrus, Linn.

41. **Celastrus pseudo-ilex**, Ett. (Plate XVII. fig. 19.)

C. foliis coriaceis, lanceolato-linearibus, sessilibus, integerrimis, nervo medio debili, secundariis camptodromis.

Ettingshausen, Tertiäre Flora von Haering, p. 70, pl. 24. figs. 30–36.

Heer, Flora Tertiaria Helvetiæ, p. 69, pl. 121. fig. 57.

I found several leaflets in the 26th bed of Bovey; unhappily most of them have been ruined in the journey, and only the piece represented in fig. 19 *b* has remained entire. I drew the piece represented in fig. 19 (magnified 19 *b*) on the spot. These are small, stiff, entire and narrow leaflets, obtusely rounded at the apex. Short lateral nerves proceed from the delicate median nerve. It certainly agrees with the leaves of Haering, and those of Locle and Oeningen.

It may be compared to *Celastrus integrifolius*, Thunb., from the Cape.

Order VI. TEREBINTHINEÆ.

Fam. Juglandeæ, DeC.

Pterocarya, Kunth.

42. **Pterocarya denticulata?** (Plate XIX. fig. 5.)

Pt. foliis pinnatis, foliolis sessilibus, lanceolatis, acuminatis, argute et creberrime serratis, nervis secundariis numerosis.

Heer, Flora Tertiaria Helvetiæ, iii. p. 94, pl. 131. figs. 5–7.

Juglans denticulata, O. Weber, Palæont. p. 211.

Bovey, in the 26th bed.

This species remains still very doubtful, since nothing but the fragments of leaves represented was found at Bovey. The diagnosis has therefore not been made from these fragments, but from the very fine leaves that were found in our molasse; further discoveries alone can prove whether the fragments of leaves found at Bovey belong really to this species.

The leaf of Bovey is very acutely toothed, and the teeth (augmented in fig. 5 *b*) are highly inclined towards the apex. The secondary nerves are delicate, and for the most part perfectly obliterated.

Order VII. LEGUMINOSÆ, Endl.

Fam. Papilionaceæ, Linn., R. Br.

Leguminosites, Bow., Heer.

43. Leguminosites areolatus, m. (Plate XVII. fig. 20, magnified fig. 20 *b*).

L. foliolis subcoriaceis, integerrimis, ovalibus, basi valde inæquilateris, nervis secundariis subtilissimis, camptodromis, areis argute reticulatis.

Bovey, in the 26th bed.

Is very like *Leguminosites sclerophyllus* (Flora Tert. Helvet. p. 123), but much more delicate, smaller, and with a sharper reticulation. It may belong to *Copaifera*.

A small leaflet, which has unequal sides at the base. The median nerve is curved and delicate. The secondary nerves are very delicate, at a great distance from each other, and jointed in large arches. The areas are filled up with a very delicate, distinctly projecting polygonal reticulation. The areoles are of equal size.

Incertæ Sedis.

Carpolithes, Sternb., Heer, Flora Tertiaria Helvetiæ, iii. p. 139.

44. Carpolithes Websteri. (Plate XIX. fig. 6, magnified 6 *b*.)

C. fructibus oblongis, subcompressis, utrinque obtusis, supra basim incurvatam paulo constrictis, longitudinaliter rugoso-striatis, rima longitudinali dehiscentibus, monospermis, membrana interna tenera, libera (testa seminis?).

Carpolithes thalictroides, var. *Websteri*, A. Brongniart, Recherches sur les Ossemens Fossiles, par Cuvier, ii. pl. 11. fig. 5; Mémoires du Muséum, p. 317, pl. 14. fig. 6.

Carpolithes Kaltennordheimensis, Flora Tertiaria Helvetiæ, iii. p. 141, pl. 21. fig. 14, pl. 141. figs. 68 & 69.

Folliculites Kaltennordheimensis, Zenker in Leonhard und Bronn's Jahrbuch, 1833, p. 177, pl. 4. figs. 1–7.

Carpolithes minutulus, Sternb. Versuch. i. 4. p. 41.

Folliculites minutulus, Bronn, Lethæa, p. 849, pl. 35. fig. 11.

J. D. Hooker, "On some small Seed-vessels from the Bovey Tracey Coal," Quart. Journ. Geol. Soc. Lond. for Nov. 1855, p. 566, pl. 17.

Unger, Sylloge Plant. Fossil. p. 17, pl. 7. figs. 10–23.

Hippophaë disperma, Ludwig in Palæontogr. viii. p. 112, pl. 43. figs. 14–18 & 20.

Not rare in the 54th bed; very rare in the rhizome-bed.

The fruits of Bovey agree so perfectly with those of Kaltennordheim, of Rochette, &c., that they must be referred to that species. Geologically they are of great importance, as they have such a wide range in the Miocene formation; it is hence the more to be regretted that their systematic position remains still very doubtful, and that it has even not yet been shown whether these small bodies, which can so easily be distinguished by their characteristic form and structure, are fruits or seeds. Most authors (Brongniart, Zenker, Bronn, and Hooker) consider them to be fruits, while Unger (Sylloge, p. 18) declared recently that they must be seeds, referring to the seeds of coniferous trees: as such I considered them formerly, when I described them (though granting the doubts concerning their character) as *Pinus rhabdosperma*. In all those specimens which I had then seen, the peculiar constricted volva was not distinct; but it is also wanting in all the seeds of conifers which I know, as is also the prominent edge and the sculpture. More probably they are comparable with the seeds of *Samyda*, which have such a volva, and which agree besides pretty well in respect to their form; but then we must bear in mind that the organs in question are ligneous, that they are dehiscent by a longitudinal fissure, and that such facts are much against an interpretation as seeds, though in favour of the hypothesis that they might have had the organization of a fruit.

Hooker supposed them to be cryptogamic fruits, although he was not able to point out an analogy amongst the cryptogamic plants. He maintains this view by stating that in the interior of the fruit a delicate sac is frequently found, which he considers to be a sporangium. This interpretation seems to me not quite correct; the sac seems to result from the testa of the seeds. The dotted and the spiral fibrous cells covering the interior of the cavity are much more in favour of a phanerogamic than of a cryptogamic plant; and in respect of the sac remaining in the interior of the cavity, we know exactly the same organization in cherry-stones which have lain for a long time in water or in wet places. I opened a good many cherry-stones from the 'Pfahlbauten' of Robenhausen; in all, without exception, the seed had disappeared (although the shell was left intact), and in its stead a delicate sac remained, which lay close to the interior surface of the stone, and which could easily be removed. A perfect dissolution of the kernel had taken place, and only the testa remained. The organic contents of the seed must hence have become dissolved, and escaped, in a remarkable manner, through both the testa and the putamen, that no traces of them were left in the cavity of the cherry-stone. Only the ligneous cells of the stone and the testa resisted and were preserved. In the same manner, without doubt, we must account for the existence of the sac of *Carpolithes Websteri*. Sometimes an inorganic substance has been deposited in the place formerly occupied by the seed, and the interior of the cavity of the fruit is then partly filled with it.

Ludwig (*l. c.*) has united these fruits with *Hippophaë*, adopting, without necessity, a new specific name. These fruits do not, however, agree in the least with those of *Hippophaë*, and decidedly cannot be referred to that genus. He believes that great numbers of such fruits were arranged close together upon the boughs, which circumstance probably led him to refer them to *Hippophaë*. But it seems to me doubtful whether those little heaps of fruits which he represented were really fixed on the boughs that lie close by, or whether they lie only accidentally near the boughs. If they are fixed on the boughs, it will be proved that they are phanerogamic fruits and not seeds, while the interpretation as *Hippophaë* is not justified, considering the other contradictory marks.

The *C. Websteri* has been described so frequently and so carefully, that any more detailed description would be superfluous. I refer the reader especially to the very exact description of Hooker (*l. c.*). Investigation with the microscope showed me that the sac in the interior of the fruit is formed by cells with very thin walls and of different lengths (cf. fig. 6 *d*, *c*), as represented by Hooker in fig. 7, and that the pericarpium, on the contrary, is formed by ligneous cells, which partly show a very curious undulating circumscription, and are dotted (fig. 6). They are arranged in series*.

45. Carpolithes scutellatus, m. (Plate XVIII. fig. 30, magnified 30 *b*.)

C. fructibus complanatis, margine acutis, rotundatis, basi truncatis, dorso costulatis.

A few specimens in the 26th bed at Bovey.

It is a perfectly flat fruit (or seed?) with an acute margin (cf. the section of fig. *c*); at the base it is truncated, at the sides much rounded, obtusely rounded above, nearly in the middle somewhat emarginate. From the base originate a few delicate, partly ramified ribs, which reach somewhat above the middle.

It is rather like the fruits of *Panax*, but the middle partition is wanting.

Since I had only one well-preserved fragment at my disposal, I could not cut it open in order to see whether it had one or two furrows. Perhaps it may be a seed, and not a fruit.

46. Carpolithes Boveyanus, m. (Plate XIX. figs. 7–14.)

C. nucula 3–4½ mm. longa, ovata, apice mucronulata, dorso leviter sulcata, monosperma.

Frequent in the 26th bed at Bovey.

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* The drawing M. A. Brongniart has given of this species is very imperfect. I did not myself recognize his drawing as belonging to this species; but Dr. Falconer convinced me that it was so. I compared, in the British Museum, the *Carpolithes thalictroides*, var. *Websteri*, Brongn., of the Isle of Wight with the fruit from Bovey and Kaltennordheim, and am assured that they form one species. But the *Carpolithes thalictroides*, Brongn., must be separated from *Carpolithes Websteri*, as the fruit of the former species is cylindrical and acuminated, whilst the fruit of *C. Websteri* is obtusely rounded. Unhappily the place where these specimens of the Isle of Wight were found is not mentioned in the British Museum. The stone is dark, and different from the White Clay of Alum Bay, where plants are lying. Perhaps they are from the Bembridge series. Latterly I have received many seeds of this species from the Hempstead beds of the Isle of Wight.

It occurs of two different dimensions; some are 3 millims. long and 2½ millims. wide; others are 4–4½ millims. long and 3½ millims. wide. They agree, however, with the exception of the dimensions, so perfectly, that they cannot be separated.

These fruits are short, oval, rounded at the base, and furnished with a small round hole (fig. 7); the portion around the latter is somewhat wrinkled; at the apex it is furnished with a short little point. The sides are rather flat, and over each side runs a flat longitudinal furrow (fig. 8, magnified 8 *b* & 12 *b*). As the seeds lie in the soft clay, they have hardly been much compressed; the longitudinal furrows have therefore probably not been caused by the circumstance that the pericarpium was pressed in along the cavity of the fruit, but probably are characteristic of the fruit. If we open the fruit in a longitudinal section (fig. 9, and magnified 9 *b* & 10, and of the smaller fruits 13 & 14), we perceive an elliptical partition, which contained, doubtless, one seed, of which, however, nothing is preserved. The wall of the pericarpium is relatively very thick; it must therefore have been ligneous. In a few of the smaller fruits there was a longitudinal fissure.

The whole organization shows that we have here fruits, and not seeds. It is very like the fruit of *Potamogeton* (cf. *Potamogeton Eseri*, Heer, Flor. Tertiar. Helvet. i. p. 102, pl. 47. fig. 8); but the shape of the cell of the fruit (loculamentum) differs and makes it doubtful whether it belongs to this genus. In *Potamogeton* the dorsal part of the fruit is generally much more convex than the ventral part, while the apex of the fruit is somewhat incurved.

47. CARPOLITHES NITENS, m. (Plate XIX. figs. 15–23.)

C. fructibus subglobosis, nigro-nitidis, subtilissime et obsolete striolatis, monospermis, basi truncatis, cicatrice orbiculata vel angulata ornatis.

Taxus margaritifera, Ludwig, Palæontograph. viii. p. 73, pl. 60. fig. 19?

Very frequent in the coal of the 46th bed.

LUDWIG gives only a short description, which agrees, however, pretty well, but for the expression "a circular plate with a thin margin and a short stalk*," which I do not understand, and the dimensions, since his fruits are 6 millims. long, whilst those of Bovey are only 5 millims. The seeds of *Taxus* display a similar organization of the cicatrix; it is always regularly orbicular or oval; and the delicate longitudinal stripes are also met with; but the walls are much thicker, and the internal cavity is much smaller. Nevertheless I do not know any genus with seeds and fruits which are so similar to those of Bovey as the seeds of *Taxus*. If it really belong to this genus, we should have a thick ligneous testa, and but a small cavity.

These little shining black bodies have nearly the same breadth and height (of 5 millims.), and are therefore nearly orbicular, although they are frequently compressed in different directions. On the fore part of the perfectly preserved specimens we observe a little point or apex; the base is truncate, and in the middle appears a small round hole, surrounded by a cicatrix of a dull colour, which is frequently orbicular, but sometimes polygonal. If we cut them open we observe a small cavity, surrounded by a ring of shining black brittle coal (figs. 19 *b*, 20, 21 & 22). Fig. 22 is a magnified transverse section of the middle; fig. 20 (magnified 20 *b*) a similar section, but nearer the top of the fruit, which is not compressed; and fig. 19 (magnified 19 *b*, 21) a section of a compressed fruit. The wall of the fruit measures 1 to 1½ millim.; the cavity has a diameter of about 2 millims. The black shining crust which covers the internal surface is very thin. It is formed by the testa, if the organization belong to a fruit; but if it be the seed of a *Taxus*, or of some tree resembling the latter, then it ought to be considered as the remains of the albumen, while the wall forms the ligneous testa. The cavity is always filled with a whitish-grey clay. As in the *Carpolithes Websteri*, the softer internal parts of the seed were also in this case dissolved, while the cavity became afterwards filled with mineral substance. The crust of coal corresponds to the cuticula of *C. Websteri.*

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* Dünnrandige und kurzgestielte Kreisfläche.

48. CARPOLITHES EXARATUS. (Plate XIX. fig. 27, highly magnified in figs. 24–26.)

C. putamine subgloboso, 3½ mm. longo, nigro, nitido, sulcis rugoso-punctatis exarato.

In the 26th bed at Bovey.

A remarkable little object, which represents, without doubt, the stone of a fruit. It is 3½ millims. long and 3$\frac{3}{10}$ millims. wide, being thus nearly orbicular, although it is furnished with a rather blunt apex, which projects but very little, while the lower end is rounded very obtusely. At one place we observe a narrow fissure, which reaches from the apex to somewhat below the middle of the little stone, which is bordered by a narrow margin. It is, without doubt, the place where the raphe passed, and it may therefore be described as the umbilical fissure. The furrows and ribs upon the little stone are very elegant. On the truncated end (fig. 26, highly magnified) we observe a great many parallel furrows and ribs, which run very near one another to the lower termination of the umbilicus, and which pass also opposite the umbilicus across the back of the little stone; the sides too are marked by similar ribs and furrows; but here the first two are distant, and the furrows are therefore wider; the ribs run much more irregularly, forming ramifications, so that the furrows seem to be interrupted by numerous tubercles. The furrows and the ribs are covered besides with innumerable dots. (In fig. 24 *b*, a piece with a few ribs has been represented as seen under a microscope.)

Similar fruit-stones occur in *Celtis*, but we miss the umbilical fissure and the regularity of the furrows. As regards the character, the stone is more like those of *Prunus*, in which we observe on the suture a channel, within which the raphe runs till it passes through a hole below the apex of the stone towards the seeds. On the fossil we find no such small hole resembling a dot, but only the above-mentioned fissure; besides it differs in the very peculiar sculpture, and must therefore belong to another type of plants.

Fig. 27 represents the little stone of the natural size; fig. 24, the same magnified and viewed laterally; fig. 25, the same from the side of the umbilicus; fig. 26, from the base.

49. **Carpolithes vinaceus**, m. (Plate XIX. figs. 28 & 29, magnified 29 *b*).

C. semine gigantoideo, tenuissime longitudinaliter striolato, medio unisulcato.

Some pieces from the 26th bed.

This has the form and dimensions of the seeds of the grape (*Vitis vinifera*, Linn.), but it does not belong to the genus *Vitis*; the delicate longitudinal striæ, and the absence of the umbilicus within the fissure, are against such an hypothesis. It seems to me to be the seed of a monocotyledonous plant.

The seed is 6½ millims. long, and at the thicker portion 4 millims. wide; at one end it is much thickened and obtusely truncated, towards the other it is much narrowed. It has a brown, rather shining testa, marked by very delicate striæ. In some places where the testa is removed (fig. 29, magnified fig. 29 *b*), the striæ (or rather the casts of the striæ) are more distinctly visible. They form very delicate longitudinal lines, which are here and there united by transverse lines.

50. **Carpolithes lividus**, m. (Plate XIX. figs. 30 & 31.)

C. follicularis, membranaceus, brunneus, ovatus.

In the 26th bed; several pieces.

A very doubtful species. Small light-brown oval bodies, with a thin membrane. One perfectly preserved specimen (fig. 30), is $4\frac{8}{10}$ millims. long and 4 millims. wide; it is quite flattened; on the dorsal part it is furrowed by transverse wrinkles (fig. 30 *b*), which were, however, produced by shrinking; otherwise it is smooth, shining, and of a yellowish brown; on the other side there is a longitudinal fissure (fig. 30 *c*, magnified), through which probably the seed fell out, leaving the thin membrane of the pericarp. In such a case it would be a small folliculus, with probably but one seed. It is also possible that it may be the testa of a seed, and that the fissure marks the raphe.

II. *Descriptions of the Diluvial Species of Plants.*

1. Salix, Linn.

1. **Salix cinerea**, Linn. (Plate XX. figs. 1 *a*, *b*, 2 & 3.)

S. foliis lanceolato-obovatis, basi angustatis, apice breviter acuminatis, serratis vel subtiliter undulato-serrulatis, rugulosis, nervis secundariis valde camptodromis nervillisque validis.

Several leaves lie upon the soft white clay, which cannot be distinguished from those of *Salix cinerea*, Linn.; they are like the leaves which occur in the tuffs of Cannstadt. The leaves represented on Plate XX. fig. 1 *a*, *b*, are distinctly serrated; the leaf *a* with a rather sharp point; the same is seen on the leaf fig. 3, while the larger leaf, which is represented in fig. 2, has only a slightly undulated and indistinctly denticulate margin, as occurs frequently in *Salix cinerea*. The secondary nerves are perfectly like those of *S. cinerea*; they are inclined forwards, and united, forming long arches, which approach the margin. The nervules are strong, and impart to the leaf a rather wrinkled aspect.

From the midrib spring shortened secondary nerves, which are united with each lower secondary nerve, a character peculiar to the leaves of the willows.

2. SALIX, spec. (Plate XX. figs. 4 & 5.)

S. foliis petiolatis, oblongis, basi rotundatis, integerrimis (?), rugulosis, nervis secundariis valde camptodromis nervillisque validis.

This is doubtless the leaf of a willow, since it has the same characteristic nervation; the base of the leaf is obtusely rounded, and the margin seems to be entire. The specimen represented in fig. 4 has nearly parallel sides, but the base is obtusely rounded; on the margin no teeth are visible. The secondary nerves are also highly inclined towards the apex, and numerous nervules cause the wrinkled appearance of the surface. The small leaf which is represented at fig. 5 belongs undoubtedly to the same species with the foregoing, although the sides are less parallel. It is very like the leaves of *Salix amygdalina*, Linn., which vary very much in shape; but the secondary nerves and the nervules are strong, and the margin seems to be entire.

3. SALIX REPENS, Linn.? (Plate XX. figs. 1 *c–h*, 6 & 7 *b*.)

S. foliis breviter petiolatis, ovalibus, oblongis et oblongo-lanceolatis, integerrimis, nervis secundariis valde curvatis.

The most frequent leaf of the white clays. Numerous fragments lie confused in all directions.

Some forms are rather similar to those of *Salix cinerea*, Linn., but the nerves are not nearly so strongly developed: the surface of the leaf is much smoother, and the margin is not dentate.

The dimensions and the form of these leaves are very variable. The length varies from 6 to 45 millims.: some are short, oval, and obtusely rounded at the apex; others (and they are the most numerous) are oblong, and rather obtuse at the apex; whilst others are lanceolate, and have an acuminate apex. There are so many intermediate forms, that these cannot be separated. The midrib is rather slender; from it rise the secondary nerves at a rather acute angle; they are highly curved towards the apex, and near the margin they are united in arches. The areas are divided by very delicate nervules. At some places the shortened secondary nerves, which pass over to the lower secondary nerves, are visible, but in most of the leaves this important mark is not quite distinct.

As to the shape and nervation of the leaves, it seems to me most nearly allied to *Salix repens*, Linn.; but the incurvate apex is wanting, which, however, does not always exist in *S. repens*. *Salix ambigua*, Ehrh., and *S. ambigua*, Sendtner (*S. aurito-myrtilloides*), have very similar leaves.

2. BETULA, Linn.

4. BETULA NANA, Linn. (Plate XX. figs. 1 *k* & 7 *a*.)

B. foliis parvulis, orbiculatis, profunde crenatis, nervis secundariis flexuosis, craspedodromis, basalibus approximatis, areis nervulis reticulatis.

Very pretty little leaves, only 9 millims. long, and nearly orbicular. They have simple teeth, which are, however, deep and acute. From the median nerve arise on each side four secondary nerves, of which the two lowest are very much approximated. Each of them runs in a zigzag line, and terminates in a tooth; from the second spring tertiary nerves; and all are united, forming elegant polygonal reticulations, that can be traced upwards to within the teeth (cf. fig. 1 *k k*, where the leaf has been three times magnified). I saw several entire little leaves in an excellent state of preservation; there have been found besides several fragments of the leaves of this species in the white clay.

The nervation indicates the genus *Betula*. Similar forms occur in the young leaves of *Populus alba*; but in these, five primary nerves spring from the base of the leaf; while the nerves of *Betula* are pinnated, but the first ones approach the base, as seen in the fossil leaf; the reticulation also is that of *Betula*. A comparison of the different species of *Betula* leads us to *Betula nana*, Linn. The fossil leaves agree, indeed, in respect of dimensions, shape, dentation, and nervation so entirely with those of the living species, that no difference can be found; the petiole, however, is somewhat thicker than is generally the case with *Betula nana*.

Betula nana, Linn., is a boreal plant, which is at home throughout the whole arctic zone; it is found also here and there on the highland moors in Middle Europe, as, for instance, near Einsiedeln in Switzerland, and in the Jura. In the British islands it is found in Scotland only.

5. PINUS SYLVESTRIS, Linn.?

Dr. J. D. HOOKER* speaks of a pine-cone which, according to the late Dr. CROKER, was found in the upper layers of lignite. Dr. HOOKER says that it so closely resembles that of a Scotch fir (*Pinus sylvestris*, Linn.), that it might be referred to this species. I have seen it in the collection of the Geological Society in London, and another specimen in Dr. CROKER's collection at Bovey. I am of the same opinion as Dr. HOOKER; but these cones look much more modern than the plants of the lignite beds, and they are, I believe, from the diluvial formation of Bovey.

III. *Insects from Bovey.*

During my stay at Bovey I carefully searched for the remains of insects. I found indeed some traces, but they are but fragmentary, and there is only one fragment which can be determined. It is the partly destroyed elytron of a beetle, probably a *Buprestites*, and which I shall describe as *Buprestites Falconeri* (Plate XVII. fig. 21, magnified 21 *b*). It was 8 millims. long and 3 millims. wide. The angle of the shoulder is somewhat rounded, and beneath it the elytron is somewhat curved inwards. It is remarkably sculptured; with the aid of a lens we can perceive numerous round points, which are ranged in rows, and so close together that the whole elytron gets quite a *sculptura alutacea*. The species of *Agrilus*, *Lampra*, and *Anthaxia* present a similar sculpturing.

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* Quart. Journ. Geol. Soc., Nov. 1855, p. 566.

EXPLANATION OF THE PLATES.

PLATE IV.

Fig. 1. *Sphæria lignitum*, m.; fig. 2, magnified; fig. 3, more magnified. Fig. 4 *a*, *b*, *c*, *d*. *Pecopteris lignitum*, Gieb. Fig. 4 *e*. *Cinnamomum Scheuchzeri*, Hr. Figs. 5 & 6. *Pecopteris lignitum*. Figs. 7–10. *Palmacites Dæmonorops*, the fibrous bundles of the stem; figs. 11 & 12, spatha with spines; fig. 11 *b*, magnified; fig. 13, a spine; figs. 14 & 15, spines; fig. 15 *b*, magnified.

PLATE V.

Figs. 1–11. *Pecopteris lignitum*, Gieb.:—Fig. 1, the point of a leaflet (pinnula), magnified; figs. 2–4, parts of leaflets near the apex; fig. 5, many fragments of leaflets; fig. 5 *b*, seed, and *c*, the scales of a cone of *Sequoia Couttsiæ*; figs. 6 & 7, base of the leaflets; fig. 8, leaflet restored; figs. 9–11, young fronds. Figs. 12–15. *Lastræa Stiriaca*, Ung., sp.; fig. 12, fragment of a leaflet; fig. 13, leaflet with the sori, from Monod; fig. 14, pinnated leaf; fig. 15, leaflet.

PLATE VI.

Figs. 1–7. *Pecopteris lignitum*, magnified. Fig. 8. *Lastræa Stiriaca*, magnified.

PLATE VII.

Fig. 1. Rhizome of *Pecopteris lignitum*; fig. 2, rachis, with scars of the roots. Fig. 3. *Pecopteris Hookeri*, m.

PLATE VIII.

Sequoia Couttsiæ, m.:—Fig. 1, cone and seeds; fig. 2, cone, magnified; fig. 3, scales of the cone, magnified; fig. 4, scales of the cone; fig. 5, young shoots; figs. 6–8, young shoots, magnified; fig. 9, biennial branch; figs. 10 & 11, older branches; fig. 12, young shoot with the leaves, magnified; fig. 13, branch with three shoots in a verticil; figs. 14, 16 & 18, cones; figs. 15, 17 & 19, these cones restored.

PLATE IX.

Figs. 1–46. *Sequoia Couttsiæ*, m.:—Figs. 1 & 2, biennial branches; figs. 3–6, young shoots; fig. 6 *b*, magnified; fig. 7, base of a young shoot, magnified; fig. 8, young shoot, magnified; figs. 9, 11 & 12 *a*, young shoots with spreading leaves; figs. 11 *b* & 12 *a a*, magnified; fig. 10, young shoot with adnate leaves; figs. 12 *b b* & 13, part of a branch with short adhering leaves, magnified; figs. 14–20, young shoots; fig. 14 *b*, leaf, magnified; figs. 21, 23 & 24, scales of a cone; fig. 22, base of cone; fig. 25, scale with the seeds; figs. 26–28, cones with separate scales; figs. 29–34, scales of cones; fig. 35 *a*, scales; fig. 35 *b*, seed; figs. 36–42, seeds; fig. 41 *b*, magnified. Fig. 43. *Amentum masculinum*; fig. 43 *b*, magnified; figs. 44 & 45, young shoots from Armissan; fig. 46, magnified. Figs. 47 & 48. *Sequoia sempervirens*; fig. 47, seed; fig. 47 *b*, magnified; fig. 48, cone. Fig. 49. *Glyptostrobus europæus*, Br., sp., from Hohe Rhonen; fig. 49 *b*, magnified. Fig. 50. *Palmacites Dæmonorops*, Ung., sp., fruit; figs. 51–53, magnified. Fig. 54. *Cyperites deperditus*, Hr.; fig. 54 *b*, magnified.

PLATE X.

Sequoia Couttsiæ, m., restored.

PLATE XI.

Palmacites Dæmonorops, Ung., sp.:—Fig. 1, a large specimen, spatha?; fig. 2, three of the spines, magnified; fig. 3, a specimen with five spines; figs. 4–6, little spines; fig. 7, fasciculi of spines; fig. 8, spines lying in different directions; figs. 9–11, spines, magnified; fig. 9 *b*, a portion more magnified.

PLATE XII.

Fig. 1 *b*. *Lastræa Bunburii*, m., nat. size; *c*, *d*, magnified. Fig. 1 *a*. *Ficus Falconeri*, m.; fig. 1 *a a*, a portion of the surface of the leaf, magnified; fig. 1 *a a a*, more magnified. Figs. 2–9. *Quercus Lyelli*, m.; fig. 2, apex of the leaf; figs. 3, 8 & 9, base; figs. 4–7, middle piece; fig. 7 *b*, portion of leaf, magnified.

PLATE XIII.

Fig. 1 *a*, *b*, *c*. *Quercus Lyelli*, m. Fig. 1 *d*. *Phragmites œningensis*, A. Br.? Figs. 2, 3 & 4. *Quercus Lyelli*. Fig. 3 *b* & 5. *Echitonium cuspidatum*, Hr. Figs. 6 & 7. *Ficus Falconeri*, m.

PLATE XIV.

Figs. 1 & 2. *Daphnogene Ungeri*, Hr. Figs. 3–5. *Ficus eucalyptoides*, m. Fig. 6. *Laurus primigenia*, Ung. Figs. 7 & 8. *Ficus Pengellii*; figs. 7 *b* & 8 *b*, a portion of leaf, magnified. Figs. 9–11. *Dryandroides lævigata*, Hr. Fig. 12 *a*. *Dryandroides hakeæfolia*, Ung. Fig. 12 *b*. *Quercus Lyelli*. Fig. 12 *c*. *Echitonium cuspidatum*, Hr. Fig. 13 *a*. *Phragmites œningensis*, A. Br.; 13 *a a*, magnified. Fig. 13 *b*. *Dryandroides lævigata*. Fig. 13 *c*. *Sphæria socialis*, m.; fig. 13 *c c*, magnified.

PLATE XV.

Figs. 1 & 2. *Quercus Lyelli*, m., restored. Fig. 3. *Ficus Pengellii*, m., restored. Fig. 4. *Ficus Falconeri*, m., restored.

PLATE XVI.

Figs. 1–8. *Cinnamomum lanceolatum*, Ung., sp. Figs. 9–16. *Cinnamomum Scheuchzeri*, Hr.; fig. 12, branch with the flowers, from Oeningen. Figs. 17 & 18. *Cinnamomum Rossmässleri*, Hr. Fig. 19. *Sclerotium Cinnamomi*, m., magnified; fig. 19 *b*, transverse section.

PLATE XVII.

Fig. 1. *Palmacites Dæmonorops*? portion of leaf; fig. 1 *b*, five times magnified. Fig. 2. *Phragmites œningensis*, A. Br.? Fig. 3. *Poacites*, spec. Figs. 4 & 5. *Quercus Lyelli*; fig. 6, bark. Fig. 7. *Dryandroides Banksiæfolia*, Ung., sp.? Fig. 8. *Vaccinium acheronticum*, Ung. Fig. 9. *Andromeda vacciniifolia*, Ung. Figs. 10 & 11. *Andromeda reticulata*, Ett.; fig. 10 *b*, magnified. Figs. 12 & 13. *Cinnamomum Scheuchzeri*; figs. 13 & 13 *c*, flowers; fig. 13 *b*, *d*, magnified. Figs. 14 & 15. *Cinnamomum lanceolatum*. Figs. 16–18. *Eugenia Hæringiana*, Ung. Fig. 19. *Celastrus pseudo-ilex*, Ett. Fig. 20. *Leguminosites areolatus*, m.; fig. 20 *b*, magnified. Fig. 21. *Buprestites Falconeri*, m.; fig. 21 *b*, magnified.

PLATE XVIII.

Figs. 1–8. *Gardenia Wetzleri*; figs. 3–6, seeds, magnified; fig. 7 *a*, *b*, seed-vessel from Samland; fig. 7 *c*, transverse section; fig. 8, fruit from Günzburg. Figs. 9 & 10. *Eucalyptus oceanica*, Ung.? Figs. 11–17. *Nyssa europæa*; figs. 12 *b* & 17 *b*, magnified. Fig. 18. *Nyssa lævigata*; fig. 18 *b*, magnified. Fig. 20–23. *Nyssa striolata*; fig. 20 *b*, magnified. Fig. 24. *Nyssa microsperma*, m.; fig. 24 *b*, magnified. Figs. 25 & 26. *Vitis britannica*, m.; fig. 26 *b*, magnified. Figs. 27 & 28. *Vitis Hookeri*, m., fruit; figs. 29 & 29 *b*, seed; fig. 29 *c*, *d*, magnified; fig. 29 *e*, transverse section. Fig. 30. *Carpolithes scutellatus*, m.; fig. 30 *b*, magnified.

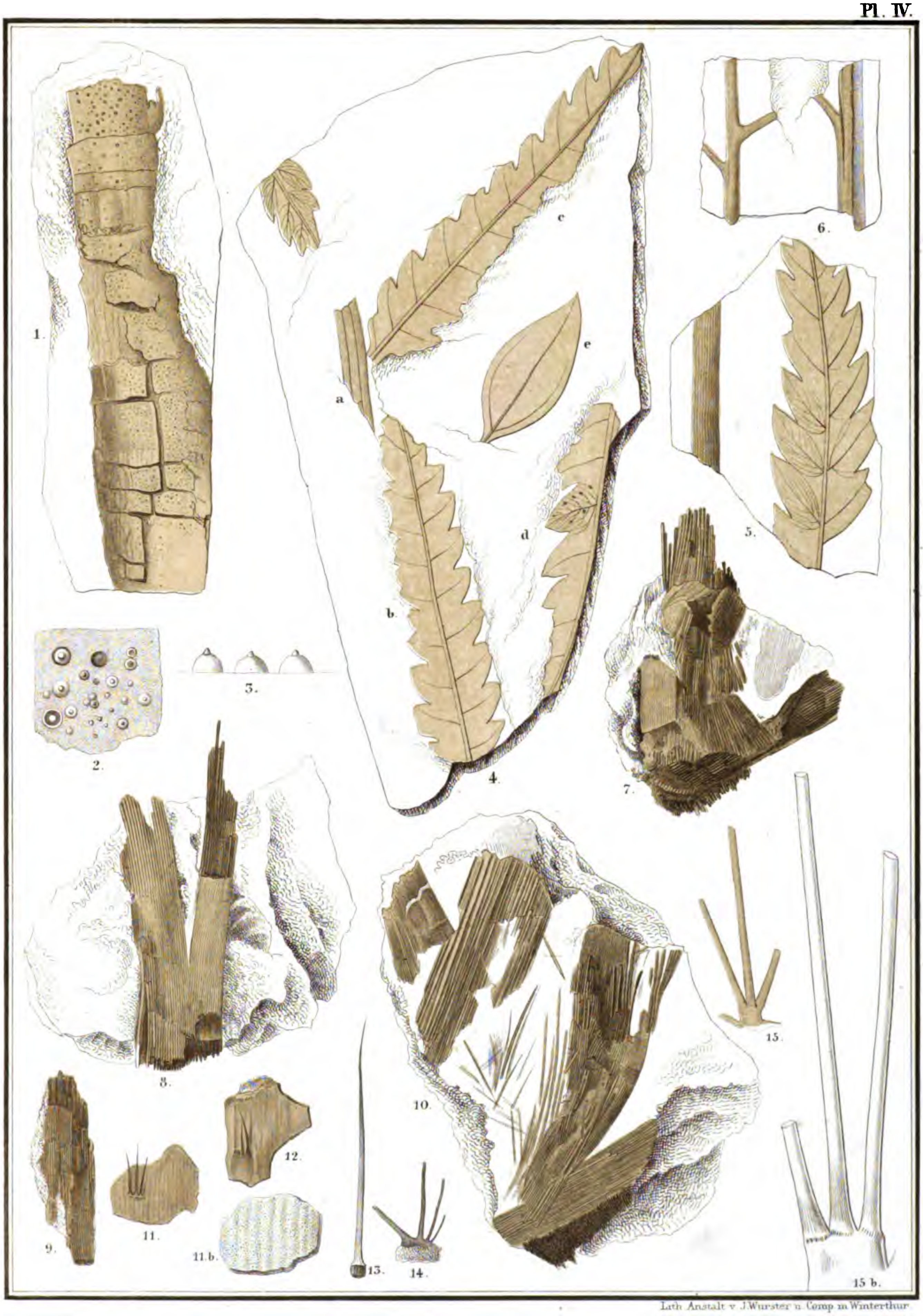
PLATE XIX.

Figs. 1–3. *Anona devonica*, m.; figs. 1 *b* & 2 *b*, transverse section. Figs. 4 & 4 *b*. *Anona cyclosperma*, m. Fig. 5. *Pterocarya denticulata*, O. Web., sp.?; fig. 5 *b* & *c*, magnified. Fig. 6. *Carpolithes Websteri*, Br.; fig. 6 *b*, magnified; fig. 6 *c*, *d*, *e*, portion of the membrane, highly magnified. Figs. 7–14. *Carpolithes Boveyanus*, m.; figs. 8 *b*, 12 *b* & 13 *b*, magnified; figs. 9 *b* & 13 *b*, vertical sections. Figs. 15–23. *Carpolithes nitens*, m.; figs. 17 *b* & 15 *b*, base of the fruit, magnified; fig. 19, transverse section; fig. 19 *b*, magnified; fig. 20, transverse section near the apex; fig. 20 *b*, magnified; figs. 21 & 22, transverse section from the middle of the fruit; fig. 23, many fruits, of natural size. Figs. 24–27. *Carpolithes exaratus*, m.; figs. 24–26, magnified. Figs. 28 & 29. *Carpolithes vinaceus*, m.; fig. 29 *b*, magnified. Figs. 30 & 30 *c*. *Carpolithes lividus*, m.; fig. 30 *c*, magnified. Figs. 32–37. *Nymphæa Doris*, m.; figs. 34 & 36, magnified; fig. 37, highly magnified.

PLATE XX.

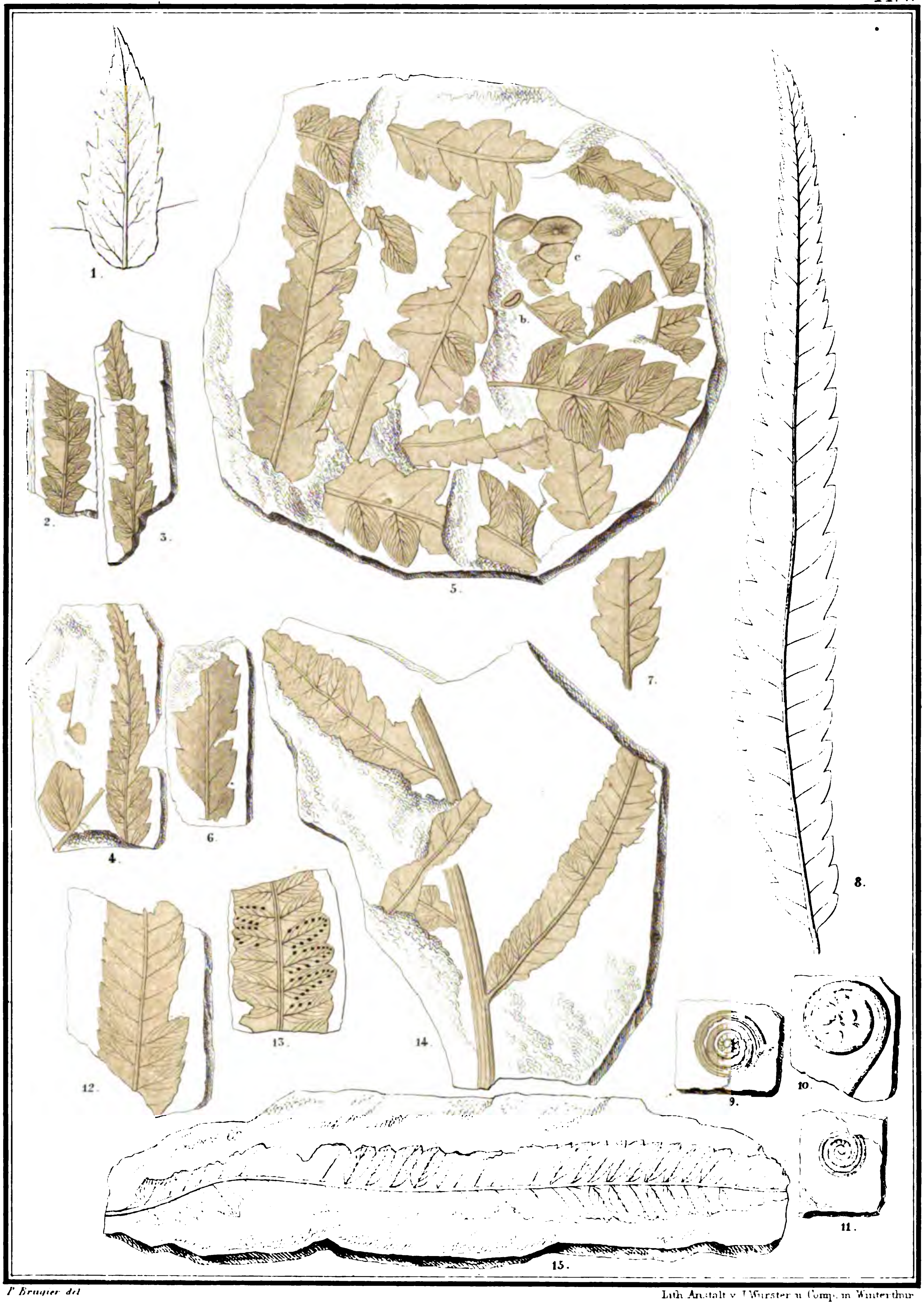
Fig. 1 *a, b. Salix cinerea*, Linn.; fig. 1 *c–h. Salix repens*, Linn.? fig. 1 *k. Betula nana*, Linn.; fig. 1 *k k*, magnified. Figs. 2 & 3. *Salix cinerea*, Linn. Figs. 4 & 5. *Salix*, sp. Fig. 6. *Salix repens*, Linn.? Fig. 7 *a. Betula nana*, Linn. Fig. 7 *b. Salix repens*, Linn.? Figs. 8 & 9, very highly magnified portion of wood.

Pl. IV.



Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

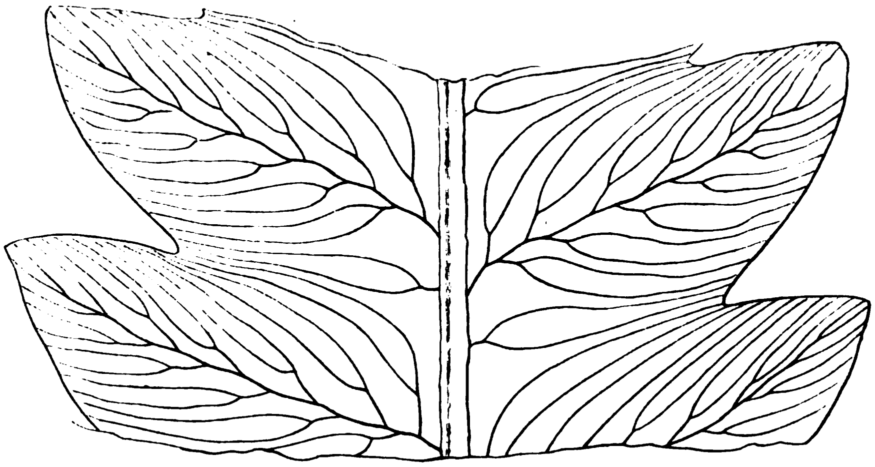
1. 2. 3. Sphaeria lignitum. 4 a–d Pecopteris lignitum. 4. e Cinnamomum Scheuchzeri. 5. 6. Pecopteris lignitum. 7–15. Palmacites Daemonorops.



F. Brugier del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

1 – 11. Pecopteris lignitum 12 – 15. Lastraea stiriaca. 5.b.c. Sequoia Couttsiae.



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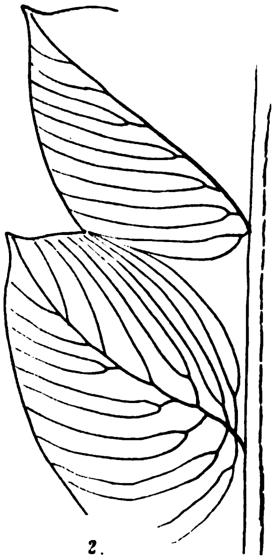

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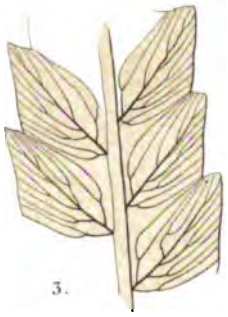

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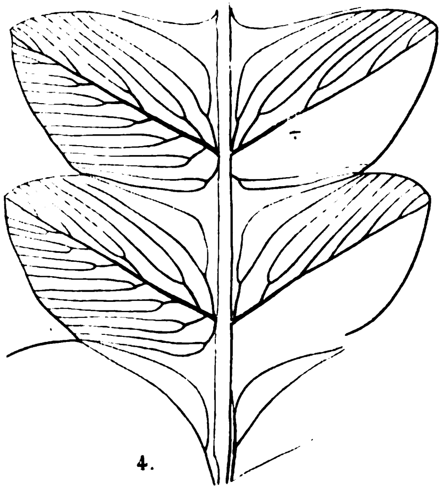

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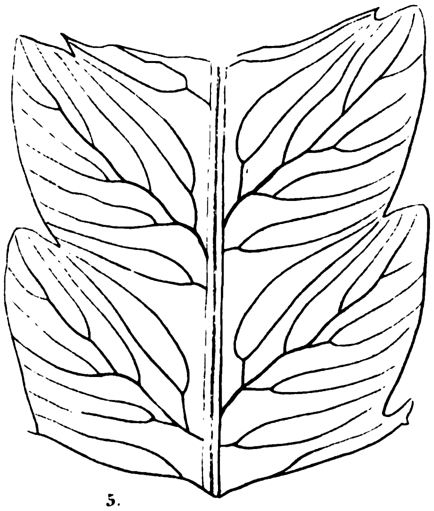

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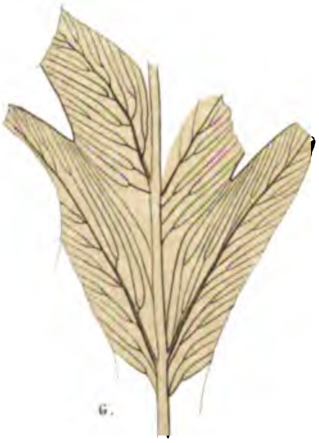

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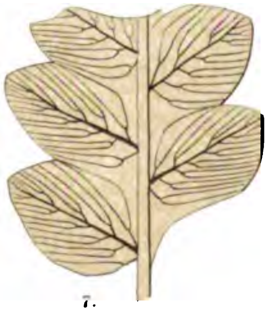

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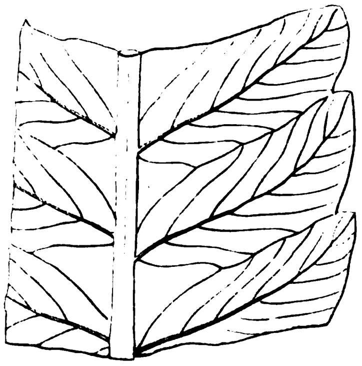
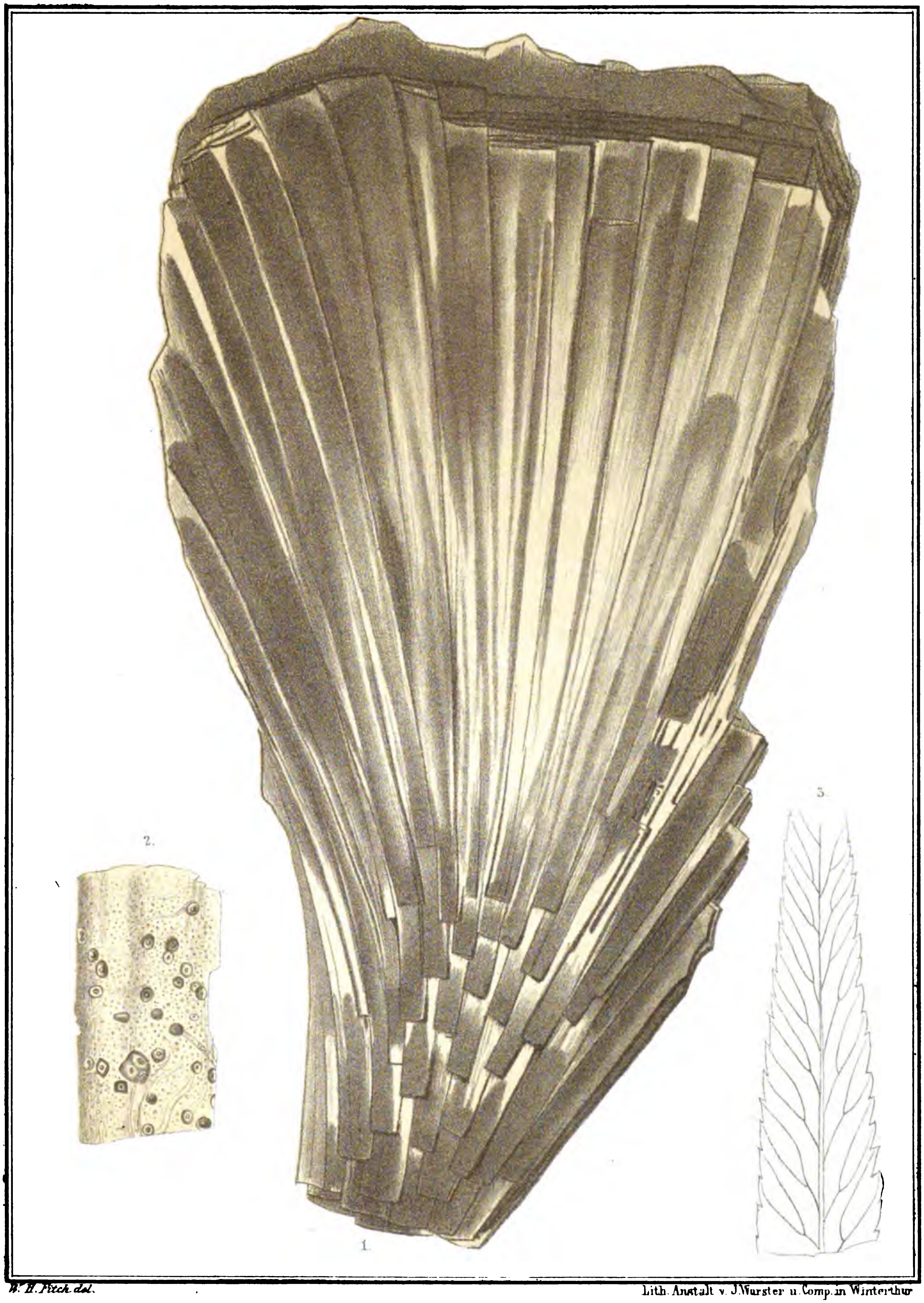


8.

Ch. Th. Gaudin et [illegible] del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

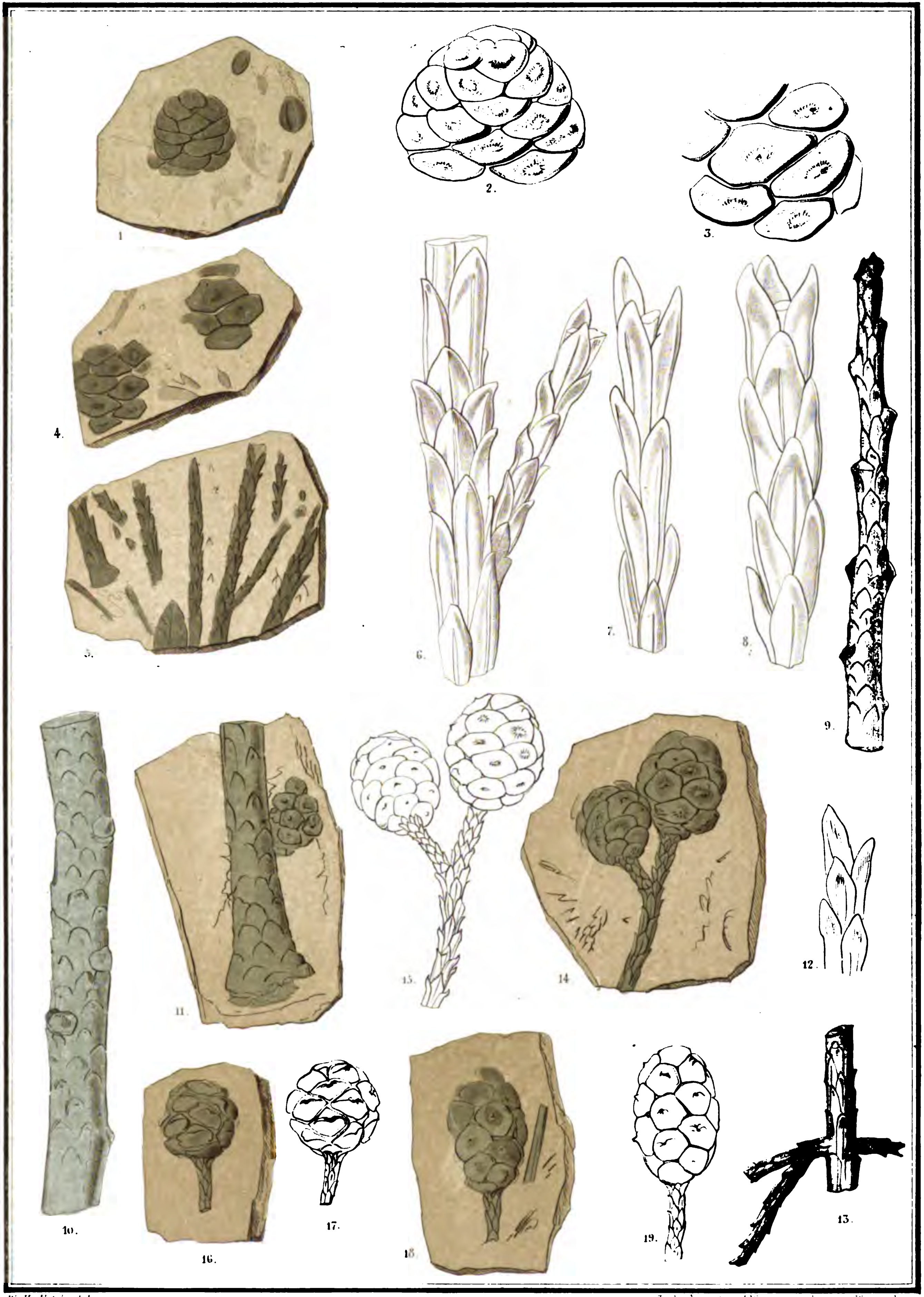
1 _ 7. Pecopteris lignitum. 8. Lastraea stiriaca.



W. H. Fitch del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

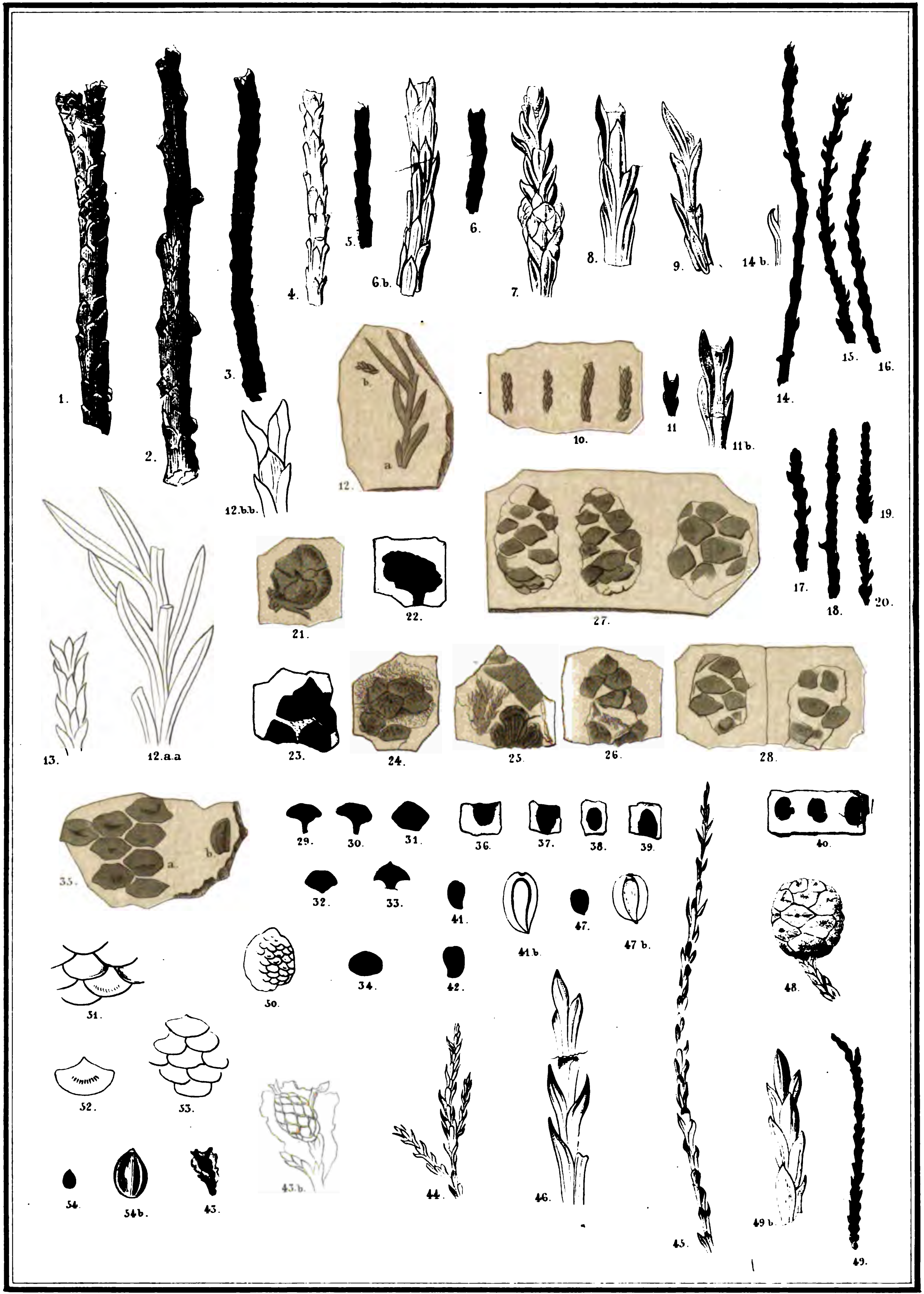
1_2 Pecopteris lignitum. 3. Pecopteris Hookeri.



W. H. Fitch del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur.

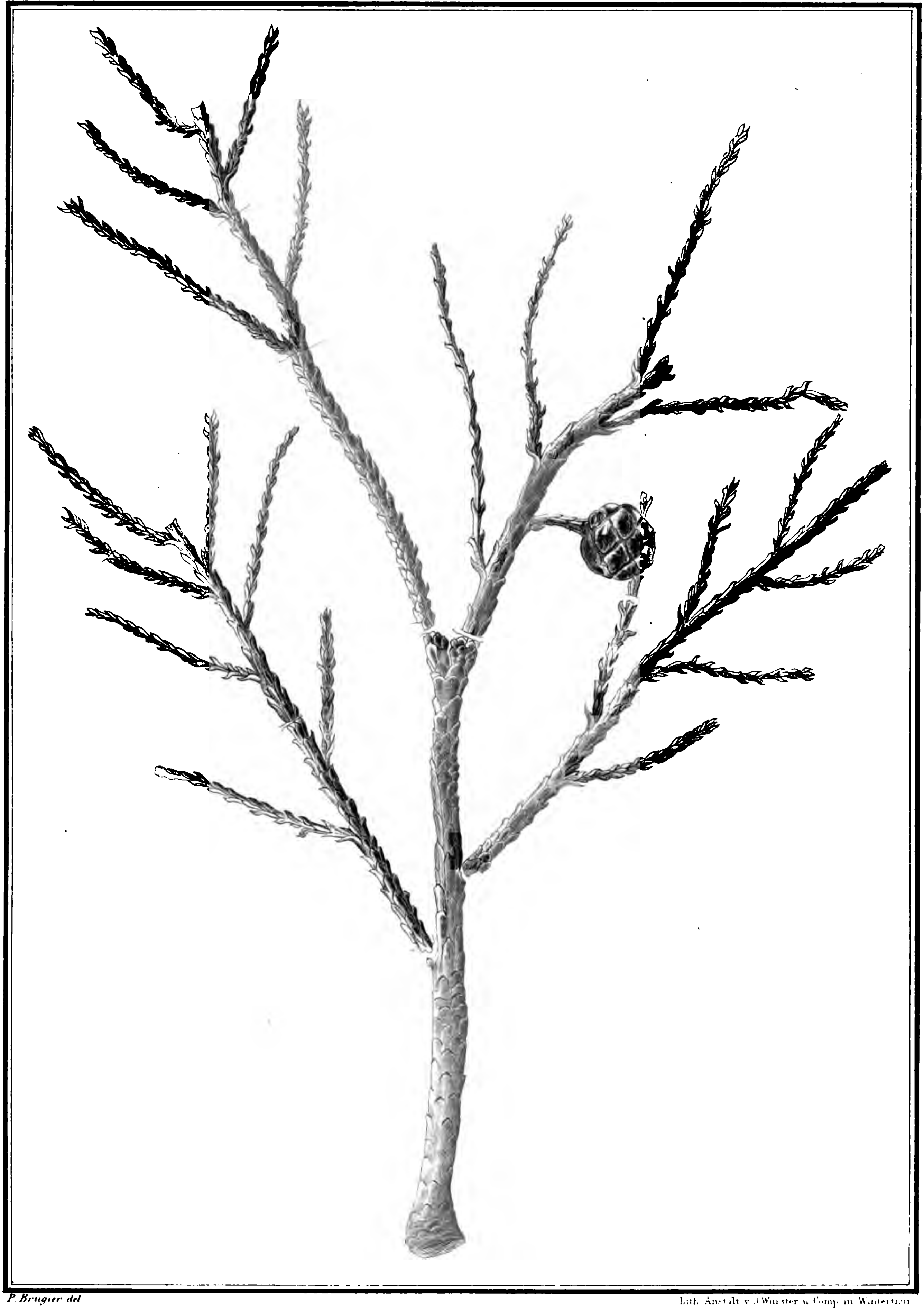
Sequoia Couttsiae.



P. Brugier del.
Lith. Anstalt v. J. Wurster u. Comp. in Winterthur.

1 _ 46. Sequoia Couttsiae. 47. 48. Sequoia sempervirens. 49. Glyptostrobus europaeus. 50 _ 53. Palmacites Daemonorops ? 54. Cyperites deperditus

Pl. X.



P. Brugier del

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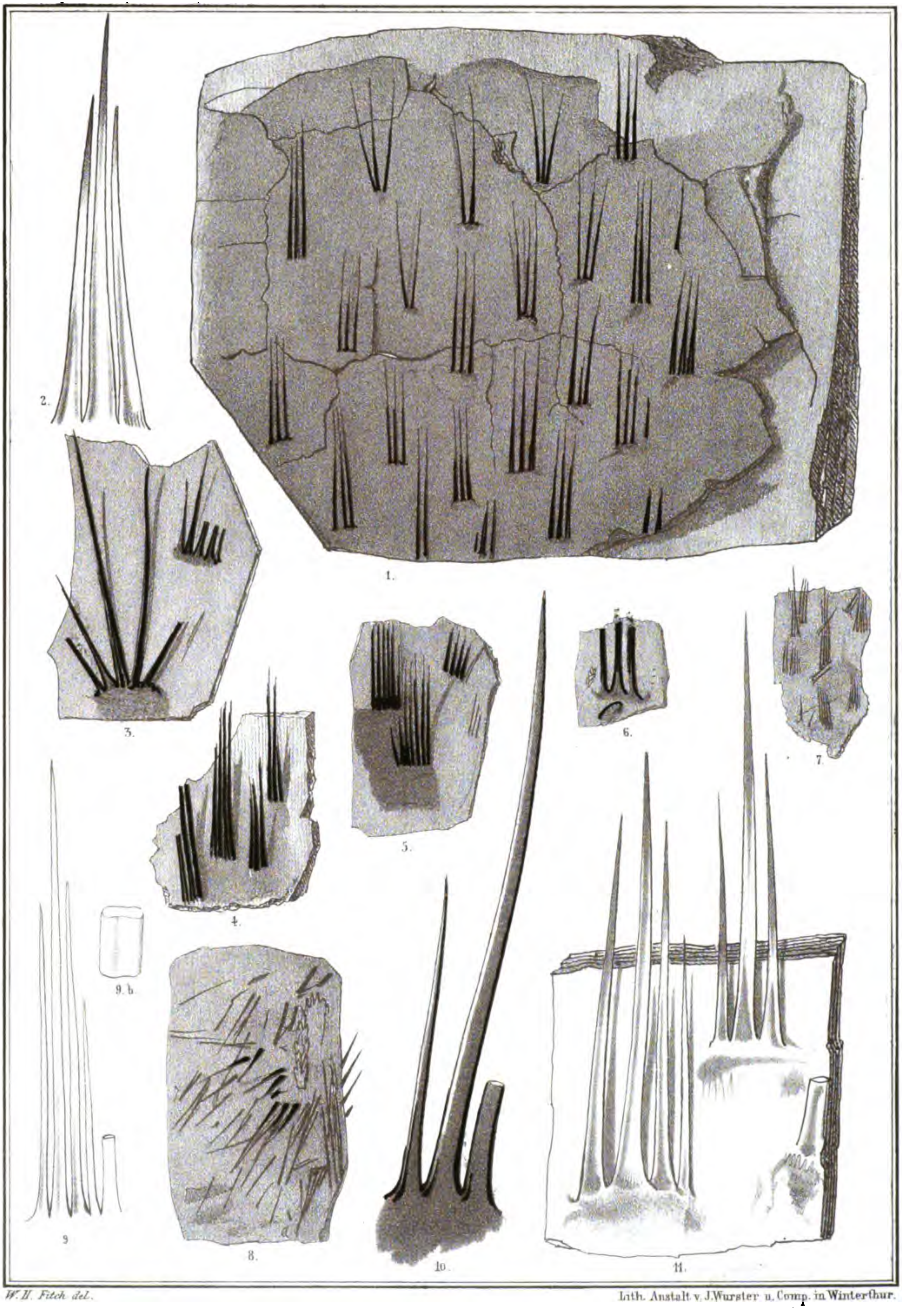
Sequoia Couttsiæ.

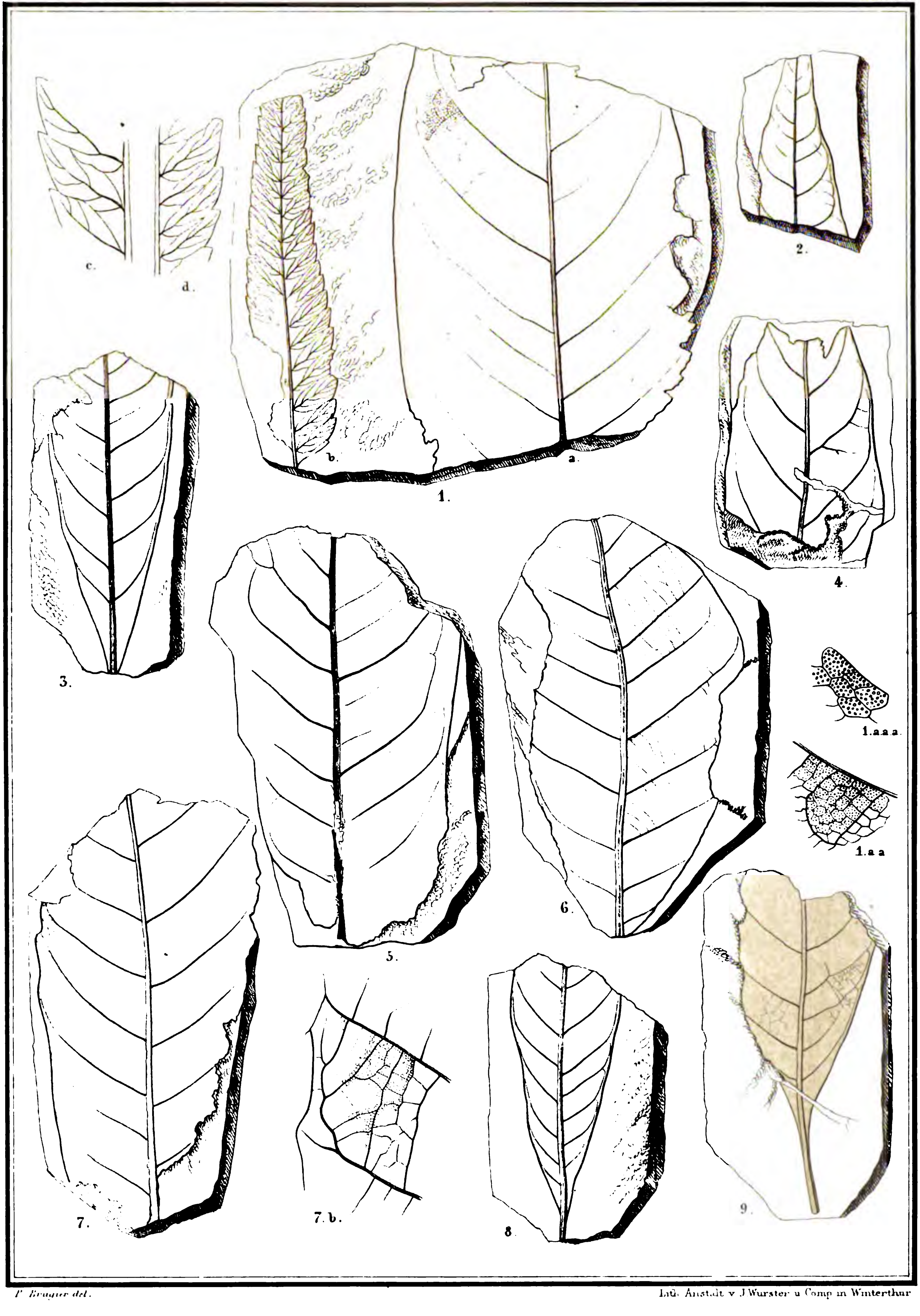
Pl. XI.



W. H. Fitch del.

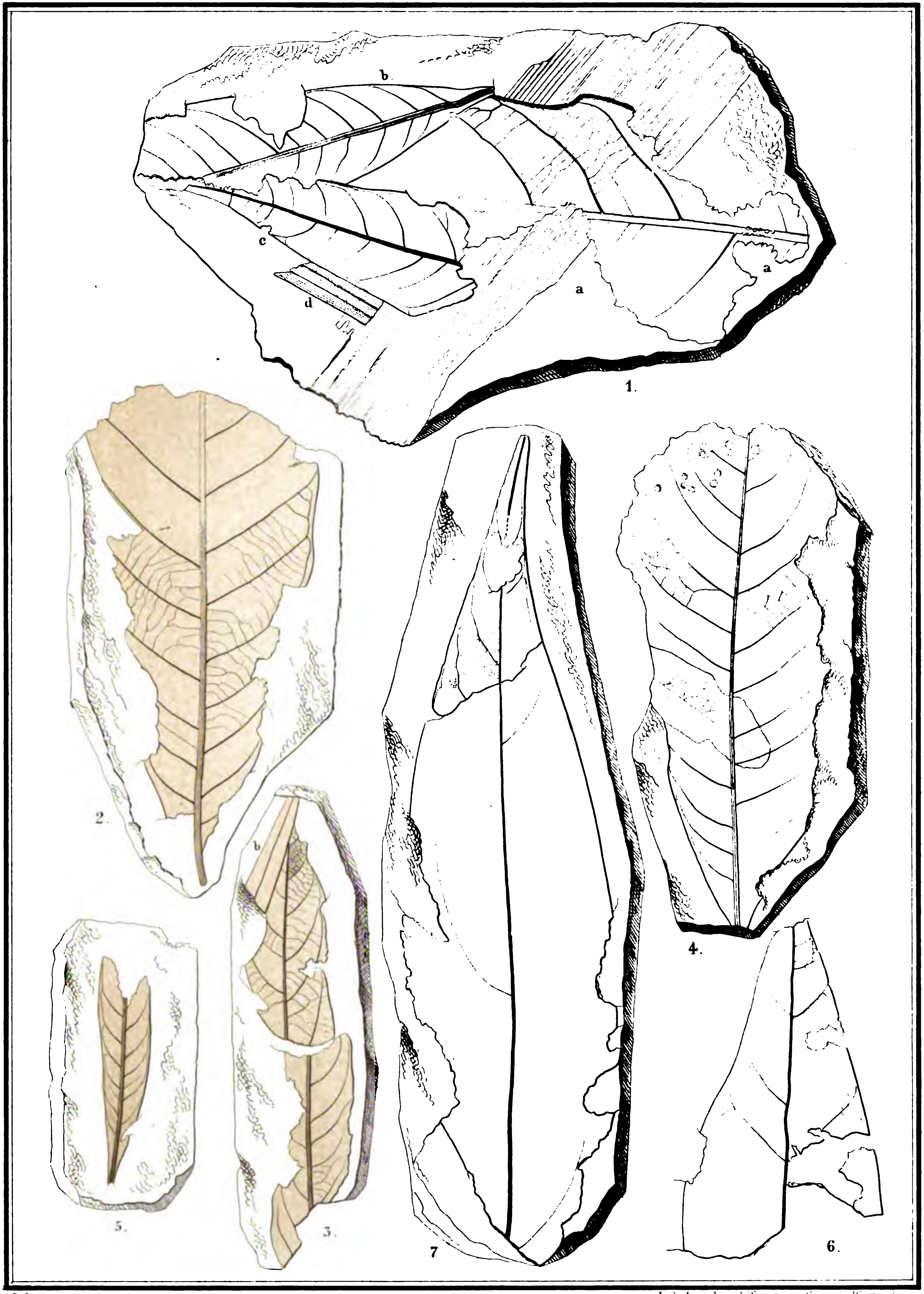
Lith. Anstalt v. J. Wurster u. Comp. in Winterthur.

Palmacites Daemonorops



F. Brugier del.
Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

1 b. d. Lastraea Bunburii. 1. a. Ficus Falconeri 2–9. Quercus Lyelli.

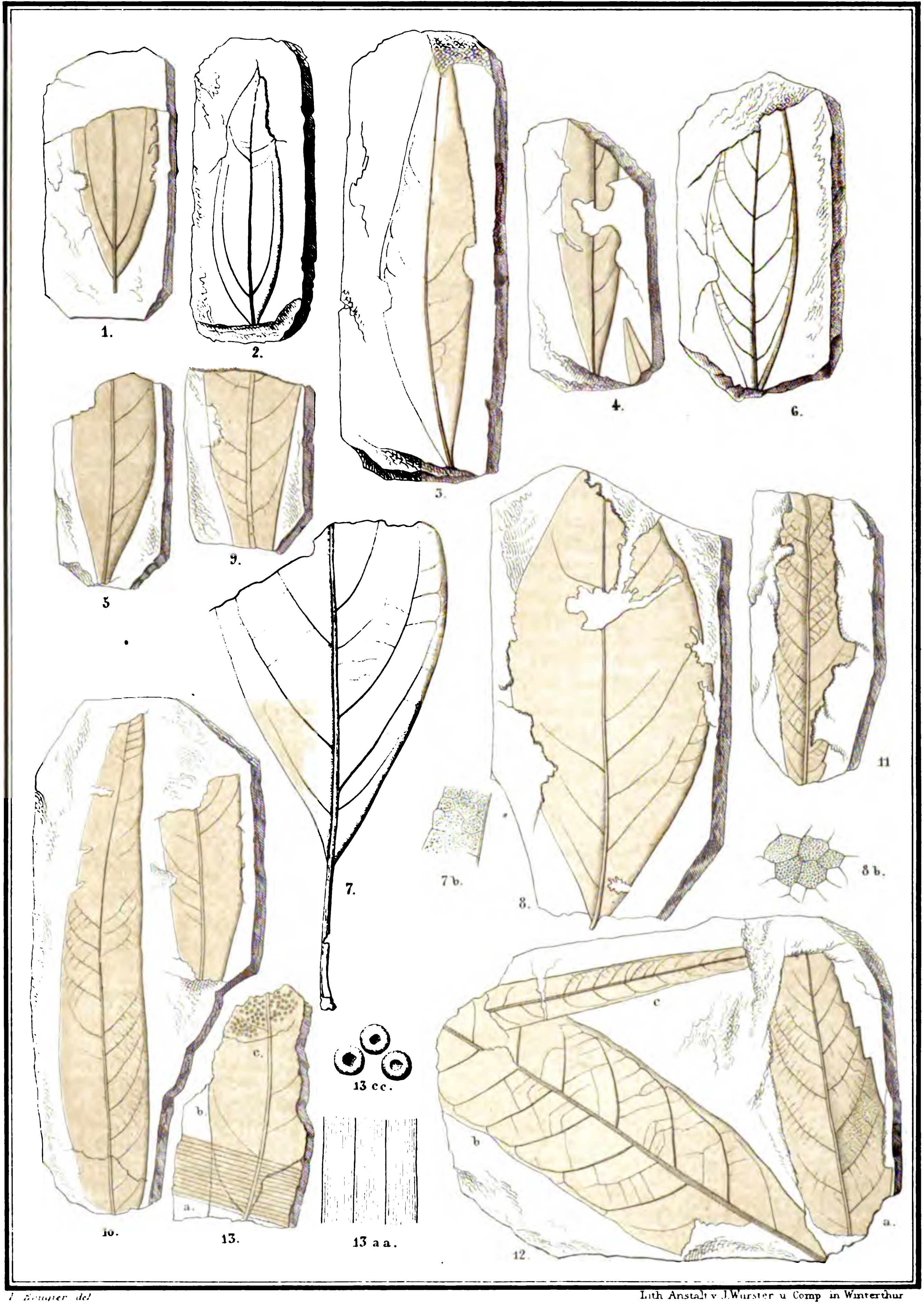


P. Brugier del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

1. a.b.c. Quercus Lyelli. 1.d. Phragmites oeningensis 2.3 a.4. Quercus Lyelli. 3 b 5. Echitonium cuspidatum. 6 7. Ficus Falconeri.

Pl. XIV.

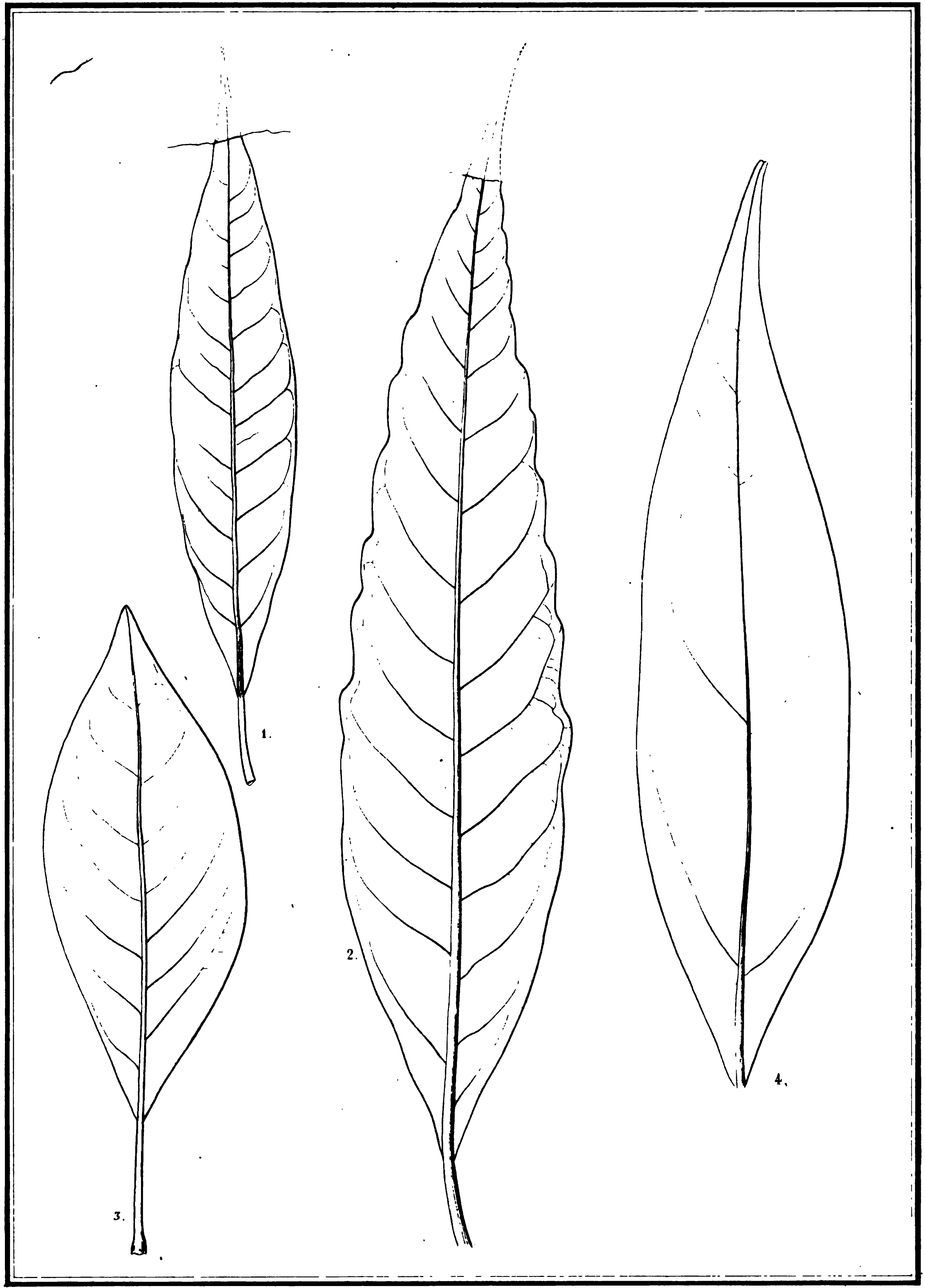


J. Sonner del

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

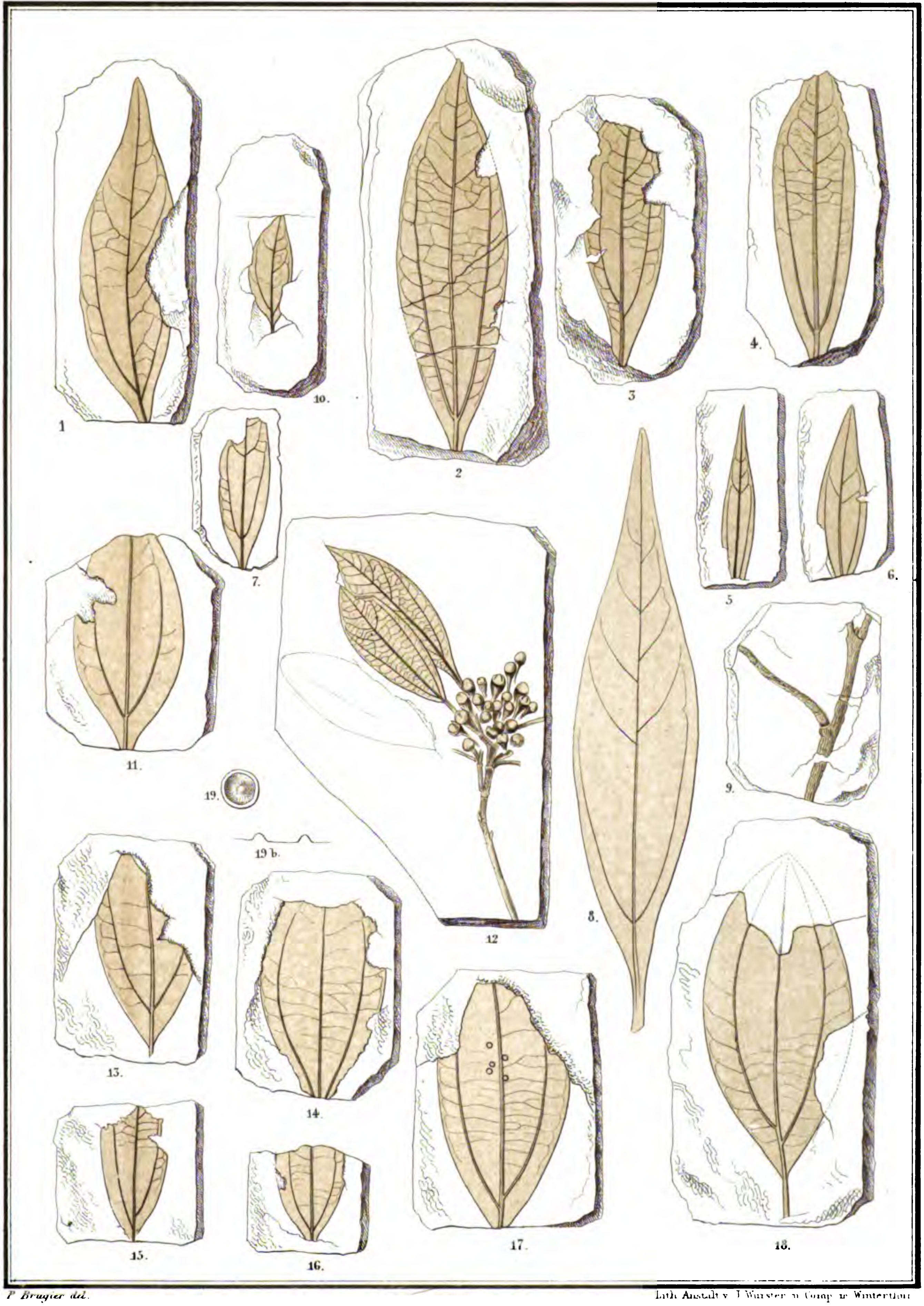
1. 2. Daphnogene Ungeri 3. 4. 5. Ficus eucalyptoides. 6. Laurus primigenia 7. 8. Ficus Pengellii. 9_11. Dryandroides laevigata. 12.a Dryandroides hakeaefolia. 12.b. Quercus Lyelli 12.c. Echitonium cuspidatum. 13.a. Phragmites oeningensis ? 13. b. Dryandroides laevigata. 13.c. Sphaeria socialis.

Pl. XV.



Brugger del. Lith. Anstalt v. J. Wurster u. Comp. in Winterthur.

1. 2. Quercus Lyelli. 3. Ficus Pengellii. 4. Ficus Falconeri.



P. Brugier del.

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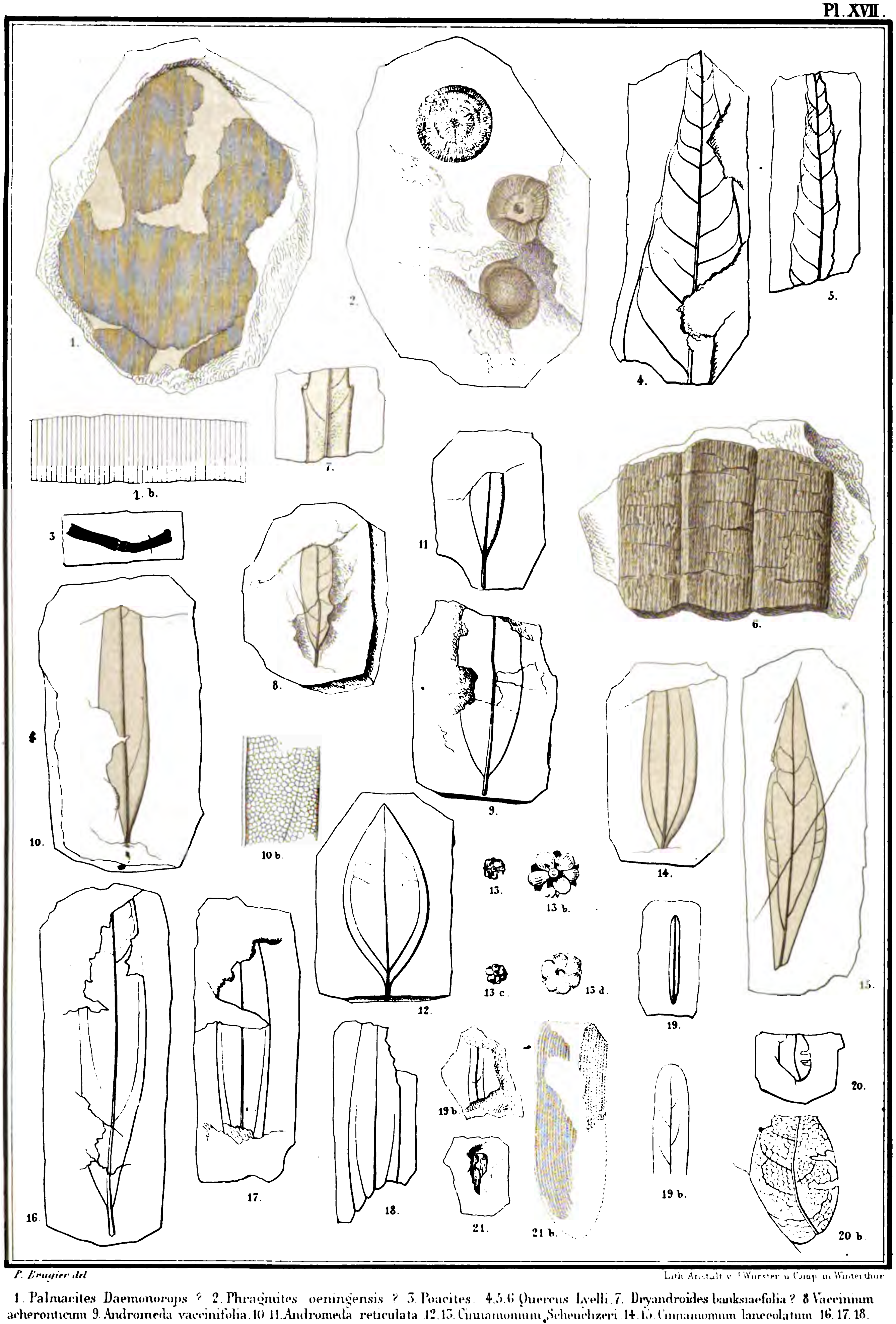
1 – 8. Cinnamomum lanceolatum. 9 – 16. Cinnamomum Scheuchzeri. 17. 18. Cinnamomum Rossmässleri. 19. Sclerotium Cinnamomi.

Pl. XVII.



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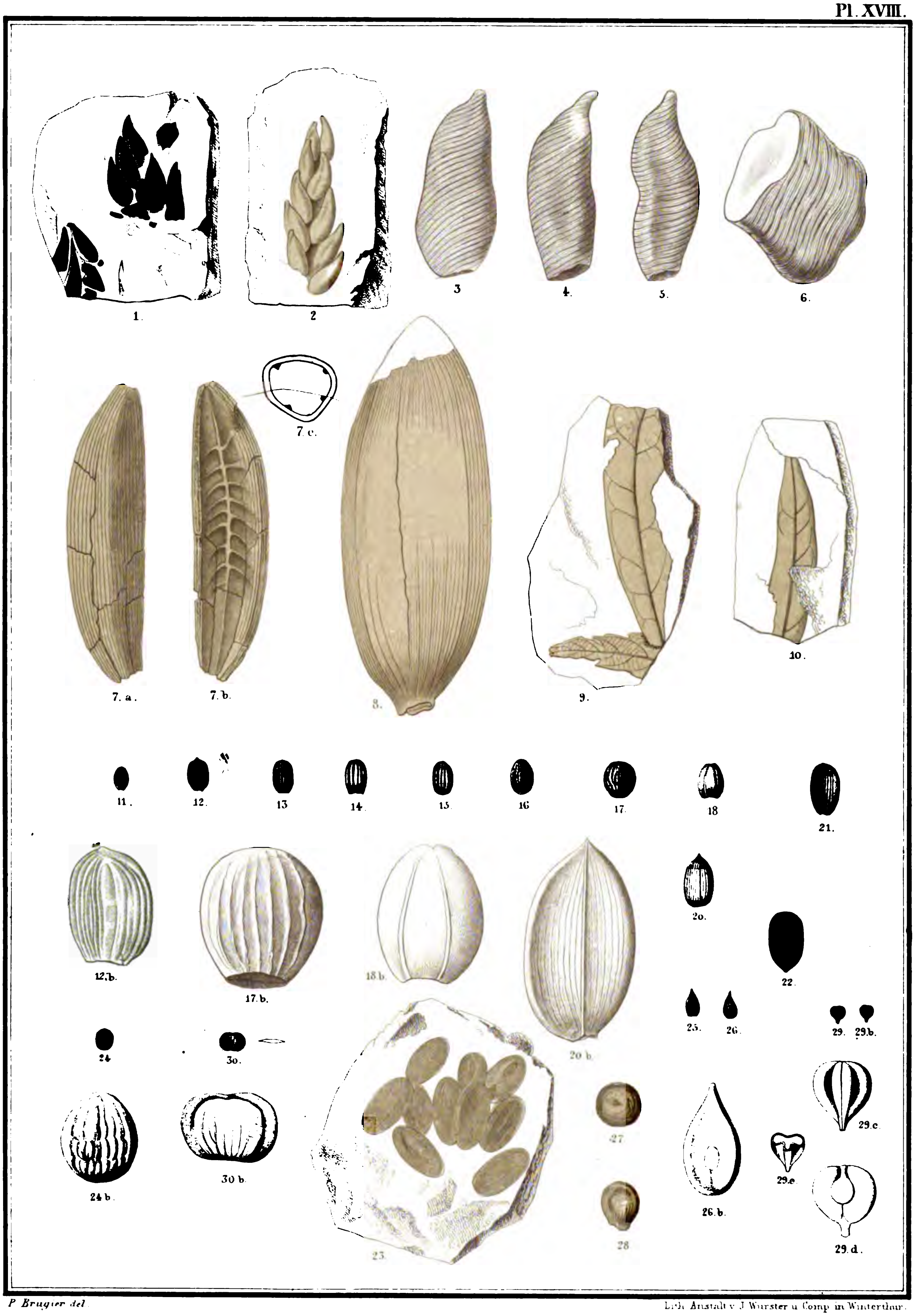
Lith Anstalt v. J Wurster u Comp. in Winterthur

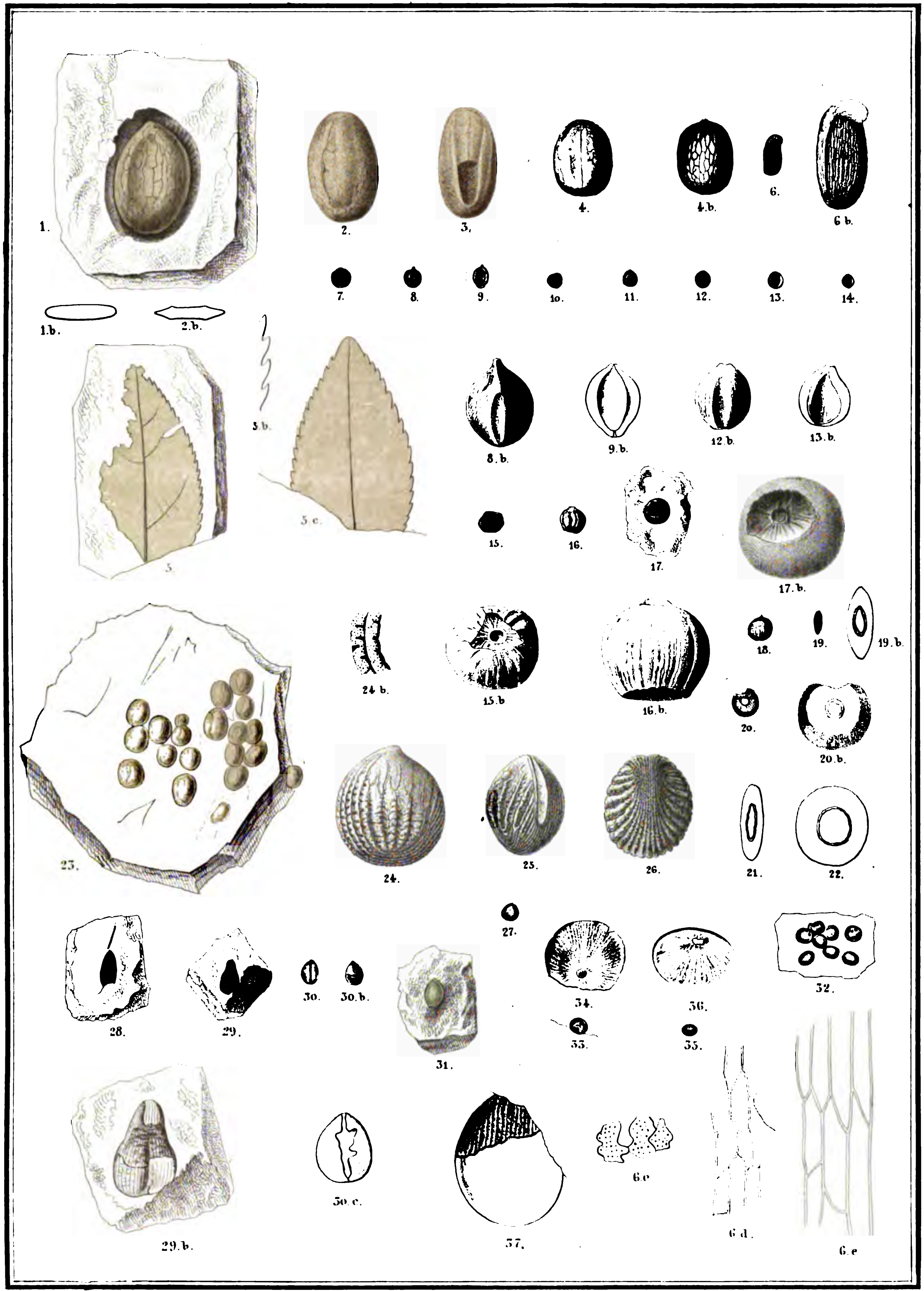
1. Palmacites Daemonorops ? 2. Phragmites oeningensis ? 3. Poacites. 4.5.6 Quercus Lyelli. 7. Dryandroides banksiaefolia ? 8 Vaccinium acheronticum 9. Andromeda vaccinifolia. 10 11. Andromeda reticulata 12.13. Cinnamomum Scheuchzeri 14.15. Cinnamomum lanceolatum 16.17.18. Eugenia haeringiana. 19. Celastrus pseudoilex. 20. Leguminosites areolatus. 21. Buprestites ? Falconeri.



P. Brugier del.

Lith. Anstalt v. J. Wurster u. Comp. in Winterthur.

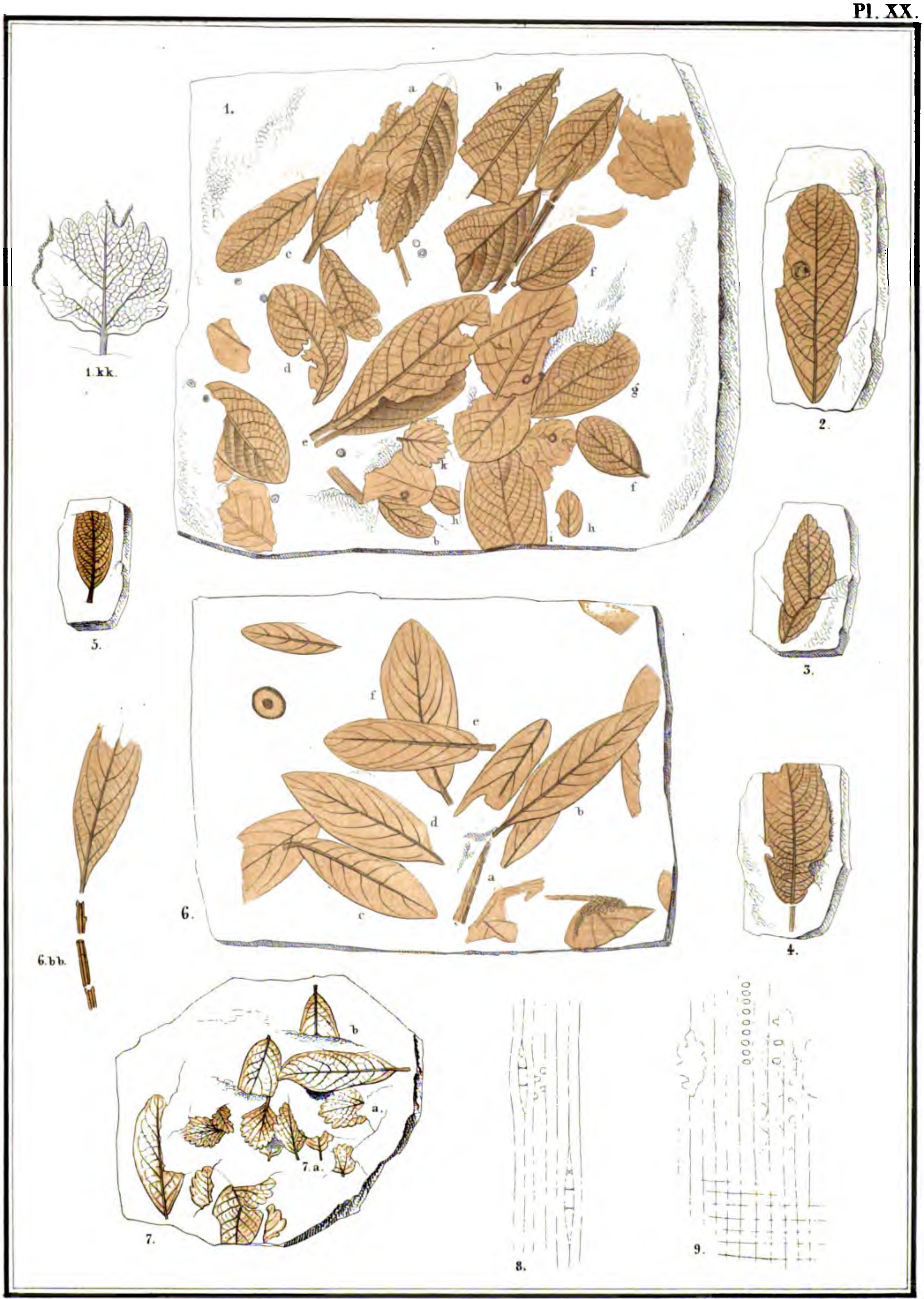
1–8. Gardenia Wetzleri. 9. 10. Eucalyptus oceanica ?. 11–17. Nyſsa europaea. 18. Nyſsa laevigata. 20–23. Nyſsa striolata 24. Nyſsa microsperma. 25. 26. Vitis britannica. 27. 28. 29. Vitis Hookeri. 30. Carpolithes scutellatus.



P. Brugier del. Lith. Anstalt v. J. Wurster u. Comp. in Winterthur

1–3. Anona devonica. 4. Anona cyclosperma. 5. Pterocarya denticulata? 6. Carpolithes Websteri. 7–14. Carpolithes Boveianus. 15–23. Carpolithes nitens. 24–27. Carpolithes exaratus. 28. 29. Carpolithes vinaceus. 30. 31. Carpolithes lividus. 32–37. Nymphaea Doris.

Pl. XX.



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1. k. Betula nana. 1. a. b. Salix cinerea. 1 c–h. Salix repens L.? 2. 3. Salix cinerea 4. 5. Salix sp. 6 7. Salix repens L.? 7. a Betula nana.